



September 2021

AIRCRAFT NOISE

FAA Could Improve Outreach through Enhanced Noise Metrics, Communication, and Support to Communities



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Why GAO Did This Study

As part of its effort to modernize the National Airspace System, FAA has been implementing new flight paths using satellite-based navigation, called PBN, at airports across the country. GAO reviewed FAA's implementation of PBN with regard to noise and FAA's related public outreach activities.

This report discusses: (1) how FAA assesses potential noise impacts for proposed PBN changes; (2) the extent to which FAA's noise impact analysis conveys expected changes; and (3) FAA's community outreach related to PBN and actions to improve this outreach. GAO reviewed FAA documents and guidance related to PBN implementation and to community outreach and mathematically analyzed how DNL levels reflect changes in noise caused by aircraft overhead. GAO conducted case studies at 13 airports selected to achieve a range of perspectives based on annual operations, the timing of PBN implementation, and geographic location, among other factors. GAO interviewed FAA and local airport officials, industry stakeholders, and community representatives in the selected locations.

What GAO Recommends

GAO is recommending that FAA (1) identify supplemental noise metrics for use in noise impact analysis for PBN implementation; (2) incorporate additional communication tools, such as supplemental noise metrics, into outreach; and (3) provide information on what the public can expect from FAA in its post-implementation outreach. FAA concurred with the recommendations.

View [GAO-21-103933](#). For more information, contact Heather Krause at (202) 512-2834 or KrauseH@gao.gov.

AIRCRAFT NOISE



FAA Could Improve Outreach through Enhanced Noise Metrics, Communication, and Support to Communities

What GAO Found

The Federal Aviation Administration (FAA) uses established policies to assess potential noise effects of implementing performance-based navigation (PBN) at airports. FAA has been implementing PBN to allow aircraft to fly more precise flight paths intended to reduce flying time, fuel use, and emissions, and PBN may reduce aircraft noise for some communities. FAA uses the Day-Night Average Sound Level (DNL) metric to meet legal requirements in assessing how these more precise flight paths—which can concentrate noise over a smaller area—might affect noise levels at various locations surrounding airports. DNL accounts for the noise intensity, duration, frequency, and time of occurrence for flights above a particular location over an average day.

GAO's analysis showed that because DNL combines the effects of several components of noise into a single metric, it does not provide a clear picture of the flight activity or associated noise levels at a given location. For example, 100 flights per day can yield the same DNL as one flight per day at a higher decibel level, due to the averaging effect of FAA's metric (see figure). GAO's analysis and other research demonstrate the limitations of FAA relying solely on DNL to identify potential noise problems. Also, community concerns about increased noise after PBN implementation, among other factors, have led to legal challenges and delays, reducing the realized benefits of PBN. Since no single metric can convey different noise effects, using additional metrics—such as changes in number of flights overhead—in designing proposed flight paths could help FAA identify and address potential noise concerns.

Examples of Different Flight-Frequency and Sound Exposure Levels Resulting in a Day-Night Average Sound Level (DNL) of 65 decibels (dB)

Flights per day, by decibel (dB) level	Day-Night Average Sound Level
1 flight per day at 114.4 dB 	65 dB
100 flights per day at 94.4 dB 	65 dB

Note: For more details, see fig. 3 in GAO-21-103933

Source: GAO analysis of Federal Aviation Administration information. | GAO-21-103933

Over time, FAA has increased its community outreach efforts throughout the PBN implementation process. However, most community stakeholders GAO spoke with said information on potential noise impacts was not clear enough to understand the planned changes. For instance, because FAA's description of the impacts is grounded in DNL, communities may not have the information needed to understand how the number of flights over each location is expected to change. Similar to the use of supplemental metrics in designing a flight path, using them in public outreach may help communities better understand expected noise changes. Furthermore, after implementing PBN, FAA primarily conducts outreach through community forums established to address noise concerns. However, members of some forums GAO spoke with were frustrated and unclear on how to productively engage with FAA to address noise concerns. FAA has some guidance on this process, but it is unclear about the extent to which communities can expect assistance from FAA in proposing changes to flight paths that cause noise concerns. Clearly communicating FAA's expected role in this outreach to the public may help alleviate community frustration.

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Abbreviations

AEDT	Aviation Environmental Design Tool
CEO	Community Engagement Officer
COVID-19	Coronavirus Disease 2019
dB	decibel
DNL	Day-Night Average Sound Level
DOT	U S. Department of Transportation
FAA	Federal Aviation Administration
LEQ	equivalent sound level
NEPA	National Environmental Policy Act
NextGen	Next Generation Air Transportation System
PBN	Performance-Based Navigation
SEL	sound exposure level
the Order	FAA Order 1050.1FAbbreviations

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September 28, 2021

Congressional Requesters

The Federal Aviation Administration (FAA) is modernizing the National Airspace System through the Next Generation Air Transportation System (NextGen) initiative. NextGen is designed to transition the nation's ground-based air traffic control system to one that uses satellite navigation, automated position reporting, and digital communications. The initiative aims to increase safety and efficiency, accommodate growing demand, and reduce environmental effects such as fuel emissions. One key component of the NextGen effort—Performance-Based Navigation (PBN)—involves making changes to existing flight procedures (that is, paths for planes to fly through the air using pre-determined flight maneuvers) to leverage emerging technologies and aircraft navigation capabilities, including satellite-based navigation.

According to FAA, PBN allows for more precise flight paths and can reduce flying time, fuel use, and aircraft emissions as well as reduce the amount of aircraft noise some communities experience. However, because PBN flight procedures are more precise, noise is likely to be concentrated over a smaller area, meaning that—while fewer communities overall experience noise—those communities directly under the PBN flight paths may experience more frequent noise. According to FAA, by 2010 the agency had implemented PBN procedures at the nation's busiest airports, and has continued to implement PBN at airports across the country.

Communities and some members of Congress have raised concerns about FAA's implementation of NextGen and PBN, including whether FAA provided timely and adequate information about potential noise effects to the public. GAO received requests to review FAA's implementation of PBN and its related public outreach activities with regard to noise impacts. Our report examines:

- FAA's approach to assessing potential community noise impacts from proposed PBN changes,
- the extent to which FAA's noise impact analysis conveys expected changes in the noise created by flights overhead, and

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- how FAA has conducted community outreach on potential noise impacts of PBN implementation and actions FAA could take to improve its outreach.

To inform these objectives, our review focused on PBN implementation at both metroplex projects (major metropolitan areas with multiple airports and complex air traffic patterns for which FAA has designed PBN procedures for several airports concurrently) and single-site airports (individual airports for which FAA has designed PBN procedures). We conducted case studies at a non-generalizable sample of 13 airports spread among four metroplexes and three single site airport projects.¹ We selected these locations to achieve a range of perspectives based on (1) total annual airport operations, (2) single-site or metroplex, (3) the status of any litigation based on community challenges to FAA's implementation of PBN procedures, (4) the phase of PBN implementation, and (5) geography. Additional information about our case study selection is included in appendix I.

To describe FAA's approach to identifying potential community noise impacts from proposed PBN changes, we reviewed FAA orders, policies, guidance, and technical manuals related to environmental impact analysis. To evaluate the extent to which FAA's noise impact analysis conveys expected changes in the noise created by flights overhead, we conducted mathematical analyses to determine how FAA's metric for understanding noise impacts—the Day-Night Average Sound Level (DNL)—is affected by changes in the number of flights overhead and noise levels. Additional information about our methodology for this analysis is included in appendix II.

In addition, we reviewed the results of FAA's noise impact analysis for PBN implementation projects at our selected locations, including data on the changes in DNL that FAA predicted as a result of PBN implementation that was documented in FAA's environmental analysis reports. Based on our reviews of FAA's environmental analysis documentation for selected locations and statements from knowledgeable

¹ The four metroplex sites in our review include the Southern California Metroplex (Hollywood Burbank Airport, Van Nuys Airport, Los Angeles International Airport), North Texas Metroplex (Dallas-Fort Worth International Airport, Dallas Love Field Airport), South-Central Florida Metroplex (Fort Lauderdale-Hollywood International Airport, Palm Beach International Airport), and Washington, D.C. Metroplex (Reagan National Airport, Baltimore-Washington International Thurgood Marshall Airport, Dulles International Airport). The single site locations for our review include Seattle-Tacoma International Airport, Chicago-O'Hare International Airport, and New York-LaGuardia Airport.

officials, we found these data reliable for the purpose of understanding the changes in noise FAA predicted as a result of the proposed projects. We determined that the information and communication component of internal control was significant to this evaluation, along with the underlying principle that management should use quality information that aligns with the expectations of both internal and external users to achieve the agency's objectives.

We evaluated FAA's methodology for identifying noise impacts (specifically FAA's use of DNL) to determine whether those methods enabled FAA to achieve its strategic goals related to PBN implementation. We reviewed reports by FAA, the U.S. Department of Transportation (DOT) Office of Inspector General, and research organizations on noise metrics and community responses to noise, including the results of FAA's Neighborhood Environmental Survey, a nationwide survey regarding annoyance related to aircraft noise. We reviewed FAA's survey methodology and found the results to be reliable for the purposes of understanding how responses to aircraft noise have changed over time. We also interviewed aviation stakeholders and aviation noise researchers to understand the strengths and limitations of DNL and how other metrics can be used for measuring noise impacts to identify potential improvements.

To evaluate how FAA has conducted community engagement activities related to PBN implementation, we reviewed FAA policies and guidance related to community involvement. For each of the selected airports, we interviewed regional FAA officials, airport officials, and representatives of communities surrounding selected airports. We also interviewed representatives from a non-generalizable sample of aviation stakeholders—such as foreign air traffic management organizations and associations representing airports, airlines, and members of the public—as well as researchers selected based on recommendations from other aviation stakeholders or who were previously identified in GAO work. More information about case study and stakeholder selection and a full list of the stakeholders we interviewed is included in appendix I.

To assess whether FAA could take any steps to improve these community outreach efforts, we compared FAA's community engagement efforts with FAA policies and guidance on complying with the National Environmental Policy Act (NEPA) and conducting community outreach as well as FAA's fiscal year 2021 *Portfolio of Goals* and guidance and best practices for conducting community outreach, including those identified by

FAA's NextGen Advisory Committee,² and Airport Cooperative Research Program.³ Additionally, we compared FAA's efforts to standards for internal control related to external communication with members of the public.

We conducted this performance audit from November 2019 to September 2021 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

NextGen

As directed in the FAA Modernization and Reform Act of 2012, FAA has continued modernizing the National Airspace System through NextGen, a multi-billion dollar effort to implement technologies and capabilities, including PBN (which relies on satellite navigation).⁴ The goal of NextGen is to improve safety, system efficiency, reduce fuel usage, and create better predictability in the system. Implementing NextGen is a complex undertaking and requires joint investments from both FAA and airlines to realize expected benefits. For example, initial estimates indicated a total cost of \$36 billion, including investment from airlines of between \$14 and \$20 billion by 2025 to equip airplanes with technology to obtain the benefits of NextGen technologies. Thus far, FAA has invested \$9 billion in NextGen implementation. However, according to a recent report by the DOT Office of Inspector General, implementation challenges have

² According to DOT, the NextGen Advisory Committee was established under DOT's authority in accordance with the provisions of the Federal Advisory Committee Act, Pub. L. No. 92-463, 86 Stat. 770 (1972), codified, as amended, at 5 U.S.C. app. 2. The objective of the NextGen Advisory Committee is to provide advice and recommendations to FAA, using consensus-based meeting methodologies, on (1) investment priorities, (2) NextGen priorities and performance analyses reports, (3) trajectory-based operations deployment and planning consistent with FAA's NextGen Vision, and (4) additional taskings received directly from FAA.

³ The Airport Cooperative Research Program is an industry-driven, applied research program that aims to develop practical solutions to problems faced by airport operators. The Airport Cooperative Research Program is managed by the Transportation Research Board of the National Academies and sponsored by FAA.

⁴ FAA Modernization and Reform Act of 2012, Pub. L. No. 112-95, § 213, 126 Stat. 11, 46-50.

delayed and reduced the scope of planned programs, lowering the expected benefits.⁵ The report notes that FAA is making progress on implementing lessons learned, which will help FAA set stakeholder expectations, secure additional industry investment, and continue to make progress in improving the efficiency of the National Airspace System.

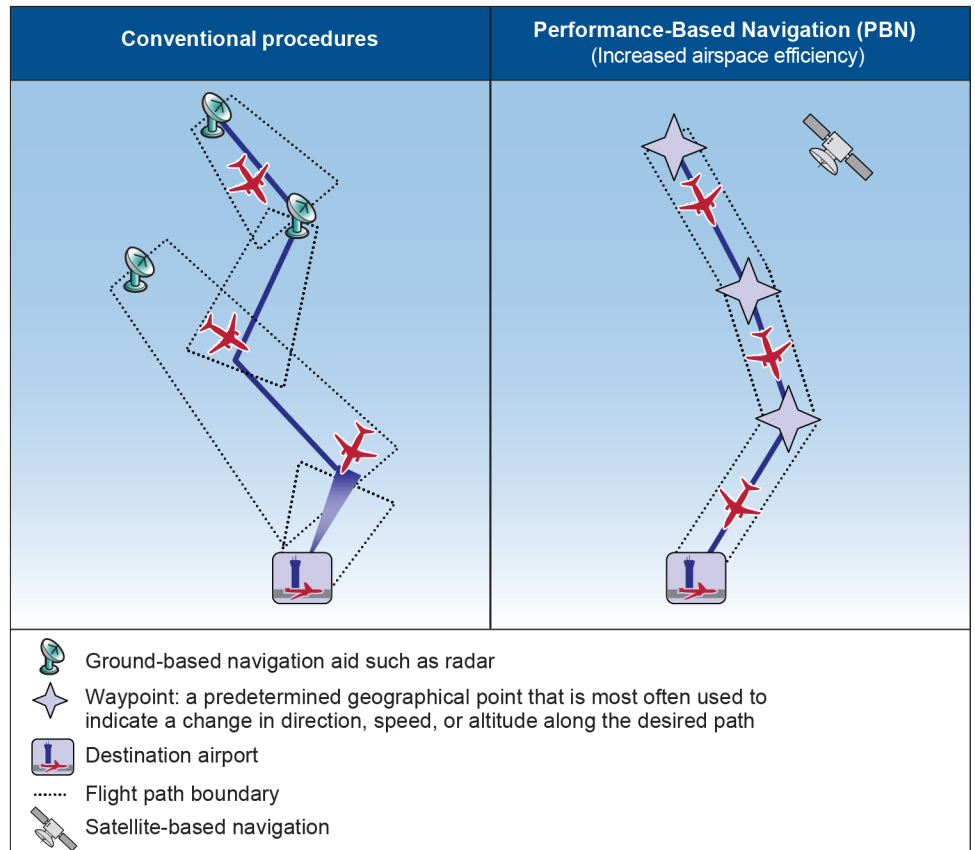
Performance-Based Navigation

One component of the NextGen program is to safely improve the overall efficiency of the National Airspace System by implementing PBN. The precision and predictability of PBN procedures increase safety and may allow more planes to safely fly in a given airspace at the same time or in closer succession, which in turn would allow for increased airspace capacity if demand increases. PBN procedures also enable aircraft to fly a particular flight path more precisely, so aircraft will be closer to the “center line” of a flight path than when using conventional navigation procedures (see fig. 1). For instance, FAA PBN usage statistics consider a flight to adhere to a conventional (non-PBN) procedure if the aircraft is within 2 nautical miles of the center line of the procedure, whereas adherence to PBN procedures requires that the aircraft be within 1 nautical mile of the center line (reducing the total airspace over which planes can be dispersed by half). This approach means that more planes will fly along a narrower path, rather than being spread across a wider path.⁶

⁵ Department of Transportation, Office of Inspector General, *NextGen Benefits Have Not Kept Pace With Initial Projections, but Opportunities Remain to Improve Future Modernization Efforts*, AV2021023 (Washington, D.C.: March 30, 2021).

⁶ PBN procedures include both Area Navigation (often referred to as RNAV) and Required Navigation Performance procedures. For the purposes of this report, we broadly refer to PBN procedures rather than differentiating between these two types.

Figure 1: Comparison of Aircraft Flight Procedures Using Conventional and Performance-Based Navigation



Sources: Federal Aviation Administration and GAO. | GAO-21-103933

Aviation stakeholders have noted that implementing PBN procedures requires tradeoffs, and the national interest, interests of industry stakeholders, and the interests of local communities must be balanced against each other. For instance, fuel efficiency goals may require tradeoffs with reductions in exposure to aviation noise because the most direct (and fuel-efficient) route may require more aircraft noise over populated areas.

A PBN implementation project begins with a proposal to make a change submitted either by an outside stakeholder (such as an airport or airline) or initiated within FAA. The proposal is assessed based on the potential benefits of the proposed change (such as increased safety or efficiency) and, if approved, a working group is assembled—comprised of FAA

officials as well as airline and airport representatives—to design PBN procedures that achieve the goals of the project. According to FAA, throughout the design process, an FAA environmental protection specialist advises the working group on addressing environmental considerations, including noise, and navigating the environmental review process. In some cases, FAA may make adjustments during the design process to address potential noise concerns, such as directing proposed flight paths over commercial corridors or bodies of water, and away from residential and other noise-sensitive areas.

Once FAA determines that the proposed PBN routes are technically feasible, safe, and comply with efficiency requirements, FAA proceeds with required analysis to determine the potential environmental impacts. NEPA requires that federal agencies carry out their respective missions with consideration for the environment. As such, when proposing an action or change to its programs and policies, such as making changes to the national airspace through new or modified PBN procedures, FAA must analyze the potential environmental impacts and, in certain instances, provide public notice of NEPA-related hearings, public meetings, and other opportunities for public involvement. Among the impacts FAA must consider are those caused by aviation noise.

FAA has implemented PBN using a two-pronged approach including larger metroplex projects and single-site projects that are narrower in scope:

- **Metroplex:** Beginning in 2013, FAA has implemented PBN in major metropolitan areas with multiple airports and complex air traffic patterns by designing PBN procedures for several airports with interdependent airspace. For example, the Southern California Metroplex project included more than one hundred new or revised procedures. FAA implemented the 11th metroplex project—the South Central Florida Metroplex—in 2021, and does not plan any further metroplex projects.
- **Single-Site:** Beginning prior to 2010, FAA has been implementing PBN at individual airports around the country. Single site PBN implementation may take place at an airport where no PBN procedures previously existed or to update or modify existing PBN procedures, and may take place at airports that were previously part of a metroplex project. As of July 2021, FAA has completed the implementation of hundreds of PBN procedures and is at some point in the study, design, evaluation, or implementation phase for PBN procedures for numerous other single site projects. FAA plans to

continue to modernize the National Airspace System by implementing and modifying PBN air traffic procedures at individual airports for the foreseeable future. For the purpose of this report, we refer to any project involving PBN implementation at a single airport as a single site.

Roles and Responsibilities Related to Aviation Noise and Performance-Based Navigation

Within the Department of Transportation (DOT), FAA is responsible for the safety and efficiency of the National Airspace System. A number of offices within FAA have a role in the implementation of PBN.⁷ For example:

- The Office of Energy and Environment is chiefly responsible for conducting research regarding environmental impacts, including noise impacts, and managing FAA's compliance with NEPA.
- The Office of NextGen leads the planning and development of NextGen, including PBN.
- The Air Traffic Organization designs the PBN flight paths and procedures. Within the Air Traffic Organization, environmental protection specialists lead analysis to identify potential environmental impacts.
- According to FAA officials, the Office of Airports and the Regional Administrators Office serve as the face of FAA's regional community engagement related to PBN implementation.

Additionally, in response to a requirement in the FAA Reauthorization Act of 2018, FAA established the Community Engagement Officer (CEO) position within each of FAA's nine regional offices to serve as a regional ombudsman and coordinate public outreach with the appropriate FAA officials.⁸ Within the Office of Policy, International Affairs, and Environment, the Aviation Noise Ombudsman serves as a public liaison for questions and complaints related to aircraft noise.

⁷ As FAA offices may coordinate to complete activities related to NextGen and PBN implementation, for the purposes of this report, we refer generally to FAA, rather than to specific offices.

⁸ The FAA Reauthorization Act of 2018 required FAA to designate a regional ombudsman for each of FAA's regions. Pub. L. No. 115-254, § 180, 132 Stat. 3186, 3230. In addition to the regional noise ombudsmen, FAA also has a noise ombudsman, which is a separate national position that serves as a liaison with the public on issues regarding aircraft noise. FAA has also formed a Noise Complaint Initiative group consisting of representatives from across FAA with the goal of more efficiently and effectively responding to and addressing noise complaints.

FAA also collaborates with airports and airlines in mitigating aviation noise, designing PBN procedures, and implementing PBN.

- Airports serve as an important local stakeholder in the implementation of NextGen and introduction of PBN procedures. With respect to noise, airports help FAA identify noise sensitive communities as well as participate in mitigation efforts such as funding the installation of sound insulation in homes and buildings exposed to significant aircraft noise. Airport authorities generally do not have control over many of the causes of aviation noise such as the types of aircraft in service and traffic volume (generally controlled by airlines) or flight paths (generally controlled by FAA, in coordination with airlines). However, collecting and addressing noise complaints is a shared responsibility between FAA and the airport authorities.
- Airlines are also a key stakeholder in the implementation of NextGen and PBN procedures because successful implementation depends on airlines' investment in equipping aircraft with modern technology and pilot training. Airlines are also involved in the design of PBN procedures. Additionally, airlines have a role in addressing aircraft noise concerns by, for example, coordinating with airports and FAA air traffic controllers to participate in voluntary airport noise abatement procedures in an effort to reduce noise or by transitioning their fleets to include newer, quieter aircraft.
- Industry representatives also play a formal advisory role in NextGen implementation. DOT established the NextGen Advisory Committee to provide FAA with recommendations on its implementation of NextGen, including PBN. The Committee is composed of members who represent entities including aircraft manufacturers, airports, environmental interests, airlines, and the U.S. Department of Defense. In its efforts to advise FAA, the Committee has issued reports and recommendations related to PBN implementation and related community outreach.⁹

⁹ See Radio Technical Commission for Aeronautics, *Blueprint for Success to Implementing Performance Based Navigation*, Report of the NextGen Advisory Committee in Response to a Tasking from The Federal Aviation Administration, October 2014 and Radio Technical Commission for Aeronautics, *PBN Blueprint Community Outreach Task Group*, Report of the NextGen Advisory Committee in Response to a Tasking from the Federal Aviation Administration, June 2016.

FAA Has Established Guidance and Policies for Noise Impact Analysis of Proposed PBN Changes

Level of Environmental Review Is Dependent on Potential Impact

FAA's Order 1050.1F (the Order),¹⁰ updated in 2015, establishes policies for conducting environmental analyses and community outreach to adhere to NEPA requirements when implementing PBN procedures.¹¹

The Order applies to FAA proposed actions—that is, implementation of or changes to policies, programs, or procedures—but, for the purposes of this report, we discuss these policies in relation to FAA's implementation of PBN procedures. In addition, FAA has developed a companion Desk Reference to provide additional guidance on carrying out the policies established in the Order. Once proposed PBN procedures for a metroplex or single-site project have been designed to accomplish FAA's goals, FAA conducts one of three levels of environmental review and conducts associated environmental analysis, including noise impact analysis, and public outreach as outlined in the Order and described below. These activities are discussed in greater detail throughout this report.

- **Categorical exclusion:** FAA has identified a range of actions (including changes to PBN procedures) in the Order that, in general, do not individually or cumulatively have significant effects—including noise impacts—on the human environment and, thus, are categorically excluded from the more in-depth analysis and outreach required for an environmental assessment or impact statement.

¹⁰ Order 1050.1F is derived from a broader order on considering environmental impacts issued by DOT, which in turn was developed from the regulations promulgated by the Council on Environmental Quality. See DOT Order 5610.1C, *Procedures For Considering Environmental Impacts*, July 30, 1985; 40 C.F.R. §§ 1500-1508.

¹¹ NEPA is intended to ensure agencies consider the environmental impacts of their actions in the decision making process and inform the public about their decision making. NEPA established the Council on Environmental Quality within the Executive Office of the President to ensure federal agencies meet their obligations under NEPA. Under Executive Order 11514, the Council on Environmental Quality is responsible for issuing regulations that implement NEPA's procedural requirements. Exec. Order No. 11,514, 35 Fed. Reg. 4,247 (Mar. 5, 1970).

Although FAA has classified PBN procedure changes as categorically excluded actions, FAA's Order explains that the agency must determine if extraordinary circumstances (such as protected natural or historic areas in the affected location, for example) exist that would prevent FAA from implementing the proposed change under a categorical exclusion.¹²

- **Noise screening:** According to the Desk Reference, FAA conducts noise screening analysis to determine whether it is necessary to conduct a more detailed noise analysis, and could include a range of analyses including consideration of the number of flights that would be affected by proposed changes or the extent to which proposed changes would result in movement of flights from one area to another. For example, to determine if there is the potential for significant changes in noise, FAA officials might consider the scope of the proposed change. If the change is minor or administrative in nature, and would not result in a change to the altitude or positioning of flights in the sky, then FAA could conclude that the change can be implemented without further environmental analysis. If it is clear from the screening that there will not be significant noise impacts, FAA may proceed with implementing the proposed PBN changes under a categorical exclusion. If it is unclear from the screening whether the proposed action will have significant noise impacts, FAA must conduct either an environmental assessment or impact statement, as described below.
- **Community outreach:** For PBN changes implemented under a categorical exclusion there is no requirement to involve the public. However, the Order states that FAA may notify the public of a categorically excluded change if the agency determines it is appropriate to do so.
- **Environmental assessment:** When a proposed action that would normally qualify as a categorical exclusion presents an extraordinary circumstance that may have a significant effect that cannot be lessened or avoided, or if the action does not qualify as a categorical exclusion, NEPA regulations require that FAA prepare an environmental assessment. Environmental assessments assist the agency in determining whether potential environmental impacts are

¹² The Order defines extraordinary circumstances as factors or circumstances in which a normally categorically excluded action may have a significant environmental impact that requires further analysis. Additionally, the Order states that for FAA proposed actions, extraordinary circumstances exist when the proposed action meet criteria outlined in the Council on Environmental Quality's NEPA implementing regulations.

significant and generally require more in-depth environmental analysis and additional public outreach as compared to categorical exclusions.

- **Noise impact analysis:** As part of the environmental analysis required for environmental assessments, FAA models the potential noise impacts of proposed actions and reasonable alternatives, including the environmental conditions if no change were made. If FAA does not identify potential for significant environmental impacts, including noise impacts, FAA may issue a Finding of No Significant Impact and proceed with implementing the proposed changes after appropriate public outreach.¹³ If the agency finds that the change is likely to have significant environmental impacts, which may include noise impacts, the agency must prepare an Environmental Impact Statement (see below).
- **Outreach:** For PBN changes that require an environmental assessment, FAA must involve the public to the extent practicable. FAA determines the appropriate level of public involvement on a case-by-case basis, which may vary based on the proposed action and the potential impacts. Under the Order, at a minimum, FAA must make the environmental assessment available to members of the public and may conduct additional outreach. According to the Order, in appropriate circumstances, FAA should consider public outreach activities that include seeking public comments on the draft environmental assessment as well as holding public meetings, hearings, and workshops.
- **Environmental impact statement:** When proposed PBN changes will likely have significant effects, which may include significant noise impacts, NEPA regulations require that FAA complete an environmental impact statement. In addition to information on the purpose and potential environmental impacts of the proposed PBN changes, NEPA regulations require that the environmental impact statement describe measures to mitigate adverse environmental impacts or alternatives.
- **Noise impact analysis:** Under the Order, FAA must, at a minimum, conduct the same type of noise impact analysis of the proposed action and alternatives that is required for environmental assessments. In addition, FAA may conduct additional analysis to

¹³ A Finding of No Significant Impact is a document prepared after completion of an environmental assessment. The document presents the reasons why the agency has concluded that there are no significant environmental impacts projected to occur upon implementation of the action, and that an environmental impact statement is not required.

determine the extent of significant noise impacts. In comparison with environmental assessments, environmental impact statements must include discussion of a broader range of alternatives and provide an in-depth comparative analysis of the environmental impacts from the proposed PBN changes and reasonable alternatives. Additionally, the Order requires that FAA consult with relevant federal, state, tribal, and local entities as determined based on the location and extent of the impacts.

- **Outreach:** FAA is required to conduct more formal public outreach for changes implemented under an environmental impact statement: NEPA regulations require that an agency publish a notice of intent to prepare an environmental impact statement in the Federal Register, and the Order states that FAA should coordinate with local media to notify the interested and impacted public that the document is available for review and comment. The public is able to submit comments on the draft document, and FAA must take into consideration all timely comments received. FAA must also append or otherwise publish all substantive comments received on the draft statement. The Order explains that public meetings and hearings may also be used to inform the public and receive public comments on the draft document.

Among our selected locations, PBN changes were implemented under a categorical exclusion for one project; under environmental assessments for 11 (comprised of one single site and 4 metroplex projects encompassing 10 of our selected airports); and under an environmental impact statement for one, as follows.

- Categorical Exclusion:
 - LaGuardia Airport in New York (single-site).
- Environmental Assessment:
 - Seattle-Tacoma International Airport (single site);
 - Washington, D.C. Metroplex (Ronald Reagan Washington National Airport, Baltimore-Washington International Thurgood Marshall Airport, and Dulles International Airport);
 - North Texas Metroplex (Dallas-Fort Worth International Airport and Dallas Love Field Airport);
 - Southern California Metroplex (Hollywood Burbank Airport, Van Nuys Airport, and Los Angeles International Airport); and

-
- South-Central Florida Metroplex (Fort Lauderdale-Hollywood International Airport and Palm Beach International Airport).
 - Environmental Impact Statement:
 - Chicago O’Hare International Airport in Illinois (single site).¹⁴

FAA Assesses Potential Noise Impacts from PBN Implementation at Locations Surrounding Airports Using the Day-Night Average Sound Level Metric

In support of its environmental assessments and impact statements for both single site and metroplex PBN projects, FAA assesses the potential noise impact of proposed flight path changes on locations within the area surrounding an airport by using the Day-Night Average Sound Level (DNL) metric. According to FAA, DNL is intended to reflect a person’s cumulative exposure to sound over a 24-hour period. In 1974 the U.S. Environmental Protection Agency identified DNL as the best metric to describe the effects of environmental noise in a simple, uniform, and appropriate way. The metric was adopted by FAA in 1981 in response to a requirement in the Aviation Safety and Noise Abatement Act of 1979 to establish “a single system of measuring noise” and “a single system for determining the exposure of individuals to noise which results from the operations of an airport and which includes, but is not limited to, noise intensity, duration, frequency, and time of occurrence.”¹⁵ DNL is also used by other federal agencies (such as the U.S. Department of Housing and Urban Development and the U.S. Environmental Protection Agency) for environmental analysis and regulatory purposes. DNL is a cumulative noise metric that aims to account for a community’s total potential noise exposure over an average day. DNL is expressed in decibels (dB), which measure the intensity (or loudness) of a sound.¹⁶ The higher the decibel level, the more intense the sound, and the louder it will be perceived.

¹⁴ At Chicago O’Hare International Airport, PBN procedures are being implemented as part of a larger runway modernization project. Because of the extent of the runway changes, the project is associated with significant environmental impacts and, accordingly, FAA prepared an environmental impact statement.

¹⁵ Pub. L. No. 96-193, § 102, 94 Stat. 50 (1980) (codified at 49 U.S.C. § 47502).

¹⁶ The “A-weighted” scale (represented as dBA) is used to account for differences in how people respond to sound. According to FAA, this scale most closely approximates the relative loudness of sounds in air as perceived by the human ear and provides a more useful way to evaluate the effect of noise exposure on humans by focusing on those parts of the frequency spectrum humans hear the most. Throughout this report, dB refers to A-weighted decibels.

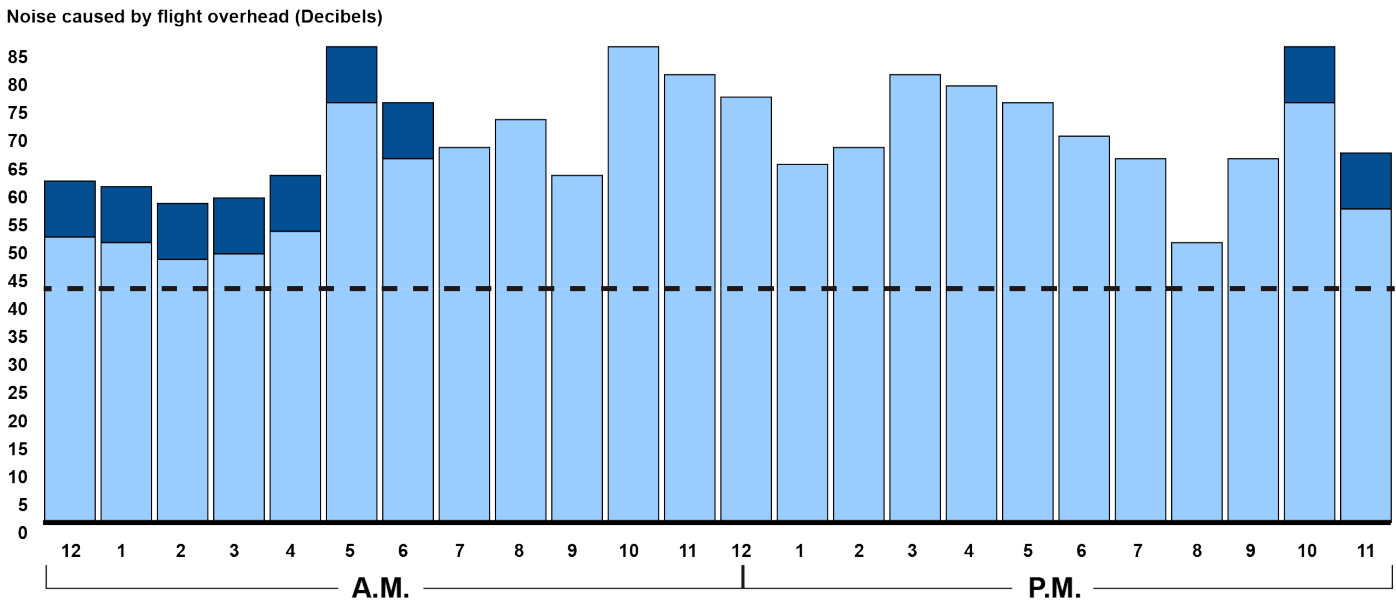
A DNL calculation includes three main components, as explained below and shown in figure 2. Additional information on how DNL is calculated is included in appendix II.

1. The amount and duration of noise created by each aircraft operation is represented by the sound exposure level (SEL). SEL is the acoustic energy (that is, the sound pressure) of an individual noise event as if that event had occurred within a one-second time period. By “squeezing” all the noise energy from the event into one second, SEL provides a uniform way to compare noise events of various durations. SEL is expressed in decibels (dB). Throughout this report, we refer to the SEL as noise caused by flights overhead (that is, a flight in the general area of the sky above a given location).¹⁷
2. The number of aircraft overhead is represented by average annual operations per day above that location (that is: the number of annual overhead flights, averaged over 365 days).¹⁸
3. The time of day the aircraft operations occur is accounted for by adding an extra 10 dB to the SEL of operations occurring between 10 pm and 7 am local time, weighting them more than day-time operations to account for people’s increased sensitivity to noise at night.

¹⁷ The formula for calculating DNL (see appendix II) equates the SEL for all flights occurring during a 24-hour period into the equivalent sound level (LEQ), which measures the average acoustic energy over a given period of time (in the case of DNL, 24 hours, with an additional night time weighting factor applied). While SEL represents the noise energy of a single noise event (a single flight overhead) as if it occurred within 1 second, LEQ represents the SEL for all the noise events at that location over a 24-hour period.

¹⁸ While the DNL metric is not defined based on an average annual day, FAA policy uses the DNL for the average annual day to determine whether potential noise impacts are significant when conducting environmental analyses.

Figure 2: The Day-Night Average Sound Level Accounts for the Number, Timing, and Noise Created By Flights Overhead



24-hour time period

- - - Day-Night Average Sound Level
- 10-decibel penalty for nighttime flights
- Noise created by 1 flight per hour

Note: Figure shows the Day-Night Average Sound Level (DNL) as represented by the dotted line for a hypothetical annual average day, with each light blue bar representing a single flight and the associated noise level, and the dark blue portion of the bar representing a 10 decibel penalty for flights occurring between the hours of 10 pm and 7 am.

Source: GAO analysis of Federal Aviation Administration information. | GAO-21-103933

Using the DNL metric, FAA considers noise changes as a result of flight path changes to be significant if there is a predicted increase in DNL of 1.5 dB or more in noise sensitive areas (such as residential areas) with a DNL of 65 dB and higher.¹⁹ Significant noise impacts trigger additional reporting requirements and mitigation efforts.²⁰ For instance, people living in areas exposed to significant aircraft noise may be eligible for sound

¹⁹ Because DNL considers a person’s cumulative exposure to aircraft noise over a 24-hour period, the noise created by individual flights overhead will generally be a higher decibel level than the DNL. For instance, as shown in figure 2, a DNL of 42 dB reflects hourly flights that are louder than 42 dB.

²⁰ Under NEPA regulations promulgated by the Council on Environmental Quality to implement the procedural provisions of the statute, an Executive Branch federal agency is required to prepare an environmental impact statement for a proposed action if that action is expected to have a “significant” effect on the quality of the human environment. 40 C.F.R. § 1502.3.

insulation programs funded by both FAA and local airports. We discuss changes in DNL and the associated changes in the number of flights overhead and noise later in this report.

For those projects that require an environmental assessment or environmental impact statement, as outlined in FAA's guidance, FAA assesses the potential noise impact of the changes based on how the PBN procedures are likely to be used. For specific locations, FAA uses data on (1) the actual and planned aircraft fleet in use at relevant airports, (2) noise created by the specific aircraft models in use, (3) actual and planned aircraft traffic levels, flight times, and flight paths, and (4) weather patterns around relevant airports, among other information.²¹ FAA models the potential noise impacts of the proposed changes at each of multiple locations for the year of anticipated project implementation and for a 5 to 10 year timeframe afterwards. For example, for a project with an anticipated implementation date of 2025, FAA might analyze noise impacts for the years 2025, 2030, and 2035 based on anticipated air traffic for those timeframes (including the types of aircraft and number of arrivals and departures at each relevant airport).

According to FAA's Desk Reference, these locations are generally identified either by using grid points in populated areas or developing noise contours around the relevant airport or airports (lines on a map that outline areas exposed to a specific DNL level). The number of locations for which FAA calculates the predicted change in DNL depends on the size of the area that could potentially be affected by the proposed changes. FAA might model noise changes at many thousands of locations for a metroplex project with PBN flight path changes proposed at several airports, while more limited PBN changes at a single airport

²¹ FAA currently uses the Aviation Environmental Design Tool (AEDT) to conduct the more detailed and precise environmental analysis required for changes that require an environmental assessment or environmental impact statement. According to FAA documentation, the tool enables FAA to consider the interdependencies between aircraft-related fuel burn, noise, and emissions; the tool can be used to study the environmental performance of scenarios ranging from a single flight to airport, regional, national, and global scenarios. AEDT became FAA's required noise model for air traffic actions in March 2012. However, for metroplex and single site PBN projects for which the development process began prior to that date, FAA used the Noise Integrated Routing System to model noise impacts (for instance, the Southern California and Washington, D.C. metroplex projects). Both AEDT and the Noise Integrated Routing System use similar inputs, though AEDT has combined noise impact analysis with analysis for other environmental impacts into a single system.

might require fewer locations to be analyzed.²² For each location and each year of the study timeframe FAA models the following:

- **No Action:** DNL if the proposed PBN procedures are not implemented.
- **Proposed Action:** DNL if the proposed procedures are implemented.
- **Alternatives:** DNL if alternative procedures were implemented (that is, if the alternative designs that FAA considered were implemented).

Based on the results of its noise analyses, FAA determines whether the estimated changes in noise levels are significant as defined in the Order, therefore requiring an environmental impact statement and public comment. Noise impacts are considered significant if implementation of the proposed procedures would cause any location to be exposed to DNL of 65 dB or more as the result of an increase in DNL of 1.5 dB or more. As such, a change from DNL 63.5 dB to DNL 65 dB would be considered significant, whereas a change from DNL 64 dB to DNL 65 dB would not. In addition to identifying noise impacts that exceed DNL 65 dB, FAA identifies reportable impacts: those that are not considered significant, but that FAA enumerates in its environmental documentation. Specifically, FAA's Order notes that changes that are not considered significant should be reported if they meet the following criteria:

- for a location with a change in noise that results in a DNL of 60 to 65 dB: an increase in DNL of 3 dB or higher, or
- for a location with a change in noise that results in a DNL between 45 dB and 60 dB: an increase in DNL of 5 dB or higher.

Among our 13 case study locations, FAA determined that there were no significant noise impacts at 12.²³ However, "no significant noise impacts" does not indicate that FAA did not identify any noise impacts at all. For instance, FAA identified many locations in the Southern California Metroplex where DNL would either increase, decrease, or stay the same.

²² For example, FAA modeled the DNL for more than 330,000 individual locations for the Southern California metroplex. In contrast, FAA modeled the DNL for about 4,700 locations in the study area for the Chicago O'Hare Airport modernization project.

²³ Environmental reviews are intended to identify potential impacts on a wide variety of environmental features. For example, FAA's Order 1050.1 identifies air quality, climate, energy supply, and socioeconomic/environmental justice factors, among others, as categories that may be relevant to FAA actions. However, for the purposes of this report, we have reviewed only noise impacts related to PBN implementation.

By contrast, and as discussed below, FAA identified significant DNL increases in locations surrounding Chicago O'Hare International Airport, where PBN implementation was conducted as part of a larger airport modernization project, including new runways. In each case, after issuing a record of decision for each project, FAA proceeded with implementation of the proposed PBN procedures.

FAA's Metric for Assessing Noise Impacts Is Limited in Conveying Expected Changes in the Number and Noise Levels of Flights Overhead

Combining Aspects of Noise into a Single Metric Limits the Extent to which Expected Changes in Noise Are Conveyed

Our analysis found that—because the DNL metric is intended to combine the effects of individual aviation noise components into a single metric—it does not provide a clear picture of expected changes in noise. This and other factors limit the usefulness of DNL in helping FAA to assess and convey to the public the full extent of expected changes. Because DNL takes into account both the amount of noise from each aircraft operation, as well as the average annual flights per day at a given location, the same DNL may be associated with vastly different numbers of flights above that location. Small numbers of relatively loud operations, for example, can result in the same DNL as large numbers of quieter operations, as shown in figure 3.

Figure 3: Different Numbers of Flights and Sound Exposure Levels Result in a Day-Night Average Sound Level (DNL) Of 65 Decibels

Number of flights per day and sound exposure level in decibels (dB) ^a			Day-Night Average Sound Level (DNL) ^b
Scenario A:	<p>1 flight per day at 114.4 dB</p>		65 dB
Scenario B:	<p>10 flights per day at 104.4 dB</p>		
Scenario C:	<p>100 flights per day at 94.4 dB</p>		
Scenario D:	<p>1,000 flights per day at 84.4 dB</p>		

Source: GAO analysis of Federal Aviation Administration information. | GAO-21-103933

Note: Sound exposure level (SEL) is a measure of the acoustic energy (that is, the sound pressure) of an individual noise event as if that event had occurred within a one-second time period.

^aDecibel (dB): A measure of sound intensity, or loudness.

^bDay-Night Average Sound Level (DNL): A cumulative measure of aircraft noise exposure at a particular location.

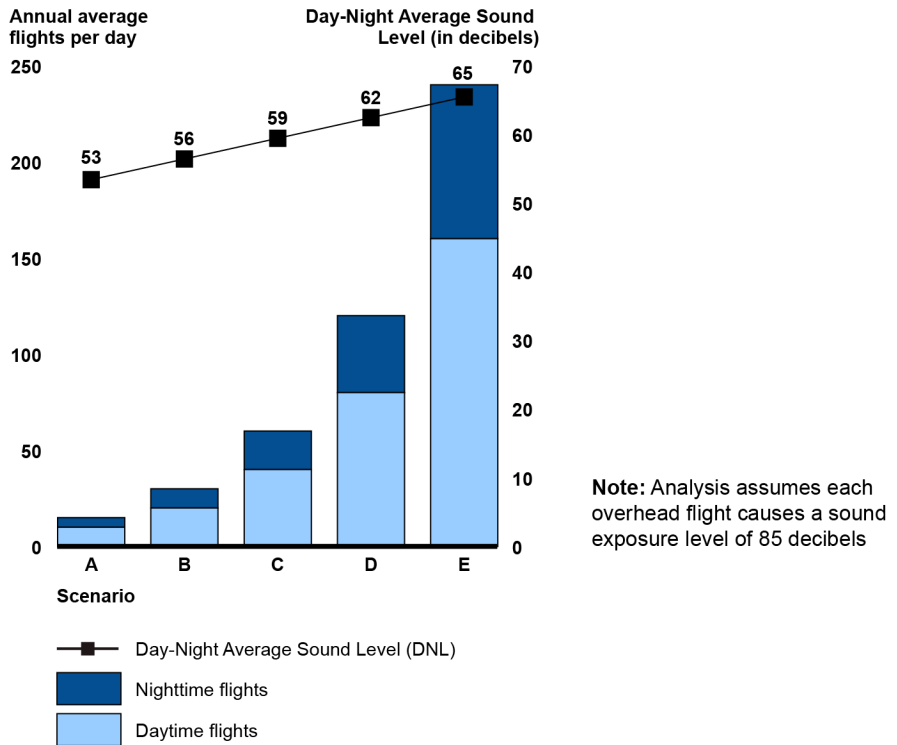
FAA officials stated that, while predicted DNL levels did not change much as a result of PBN implementation, an increase in the number of flights across the national airspace may have contributed to community concerns about noise. However, while a general increase in the demand for air travel may be a compounding factor affecting community noise concerns, the effects of PBN mean that any increase in air traffic will be concentrated along narrower flight paths, effectively increasing the noise impact on some communities while decreasing the impact on others.

To illustrate the extent to which FAA’s DNL analysis reflects the concentration of flights along the narrower flight paths enabled by PBN, as compared with traditional navigation, we calculated the DNL for a number of hypothetical situations. Our analysis showed that estimated

changes in DNL may not reveal changes in the number of flights in the sky above a given location. Figure 4 shows the DNL for various numbers of flights at a hypothetical location where each overhead flight causes 85 decibels of noise (roughly equivalent to a garbage disposal).²⁴ For a hypothetical location—assuming each flight produces the same amount of noise—doubling the number of flights increases the DNL by 3 dB; whether flights increase from 10 to 20 flights per day (an additional 10 flights), or 120 to 240 flights per day (an increase of 120 flights). Accordingly, larger and larger increases in the number of flights overhead result in the same change to DNL. In other words, depending on the number of flights that would have been overhead if the PBN change were not implemented, a change in DNL of 3 dB could result from either a relatively small change or a very large change in the number of added flights overhead per day. In figure 4, FAA would only consider the change from scenario D to E to cause a significant noise impact, because there would be a change in DNL that is both greater than 1.5 dB and results in the location being exposed to DNL greater than 65 dB.

²⁴ To account for the amount of noise a flight overhead causes, DNL incorporates the sound exposure level (SEL) of each flight overhead. Throughout this report, we refer to the amount of noise (as measured in decibels) cause by overflights when referring to the SEL.

Figure 4: Large Changes in the Number of Flights Overhead May Not Be Reflected in Day-Night Average Sound Levels (DNL)



Source: GAO analysis of Federal Aviation Administration information. | GAO-21-103933

Notes: Annual average flights per day is the average daily overhead flights for a given location over the course of a year.

This simplified analysis assumes the same type of aircraft with same weight/load, flying the same procedure over a hypothetical location—that is, this analysis assumes that each flight overhead creates the same amount of noise (a sound exposure level of 85 decibels) for someone on the ground at that location.

Beyond the limitation that DNL may not reveal changes in the number of flights overhead, additional factors may limit the extent to which the DNL metric helps FAA understand how communities may experience changes in noise. First, the link between the number of flights overhead, the noise created by each flight, and DNL may be further obscured by changes in the nature of aircraft noise over time. DNL was established as the FAA’s decision-making metric in the late 1970s and early 1980s, when individual aircraft were much noisier than they are today, and the number of aircraft

operations was much lower than current traffic levels.²⁵ The change to quieter but more frequent flights may result in lower DNL levels, even as the number of flights overhead increases. Secondly, because the DNL metric averages flight operations over an annual average day, it can mask large swings in daily flight operations (and the associated noise) that can occur at a given location from day to day caused by traffic patterns that change depending on weather or other operational factors. For instance, according to the Maryland Department of Transportation, Baltimore Washington International Thurgood Marshall Airport has two different traffic patterns that use different flight procedures depending on wind speed, direction, and weather factors: “east flow” (used about 30 percent of the time) and “west flow” (used about 70 percent of the time). Thus, the number of flights overhead may not be consistent from day to day, though the DNL would be calculated using a consistent average.

FAA’s Approach Does Not Incorporate Metrics That May Better Convey the Extent of Expected Noise Changes

DNL’s limitations may affect FAA’s assessment of the noise impacts of PBN implementation on members of the public. According to FAA officials, the agency initially lacked an understanding of how PBN implementation—and particularly the extent of flight path concentration caused by PBN—would affect communities in terms of noise because the changes in DNL as a result of PBN implementation were relatively small. Based on our analysis, this lack of understanding may have been caused by the limitations of DNL discussed above.

Furthermore, recent research indicates that public reaction to aviation noise has changed over time. FAA’s selection of DNL 65 dB as the appropriate threshold for noise mitigation for residential areas was based on a noise dose-response curve developed in the 1970s (called the

²⁵ As we have previously reported, airplanes are certificated to noise standards—defined in terms of Stages 1, 2, 3, 4, or 5—that were in effect at the time of the airplane type certification. The oldest noise standards under which U.S. airplanes currently operate are stage 3, as stage 1 and 2 airplanes have been prohibited from operating in the United States. The stage 3 standards for takeoff, landing, and sideline measurements range from 89 to 106 decibels, depending on the airplane’s weight and number of engines. The stage 4 and 5 standards are increasingly stringent (i.e., requiring that airplanes emit lower decibels) as they require noise level measurements that are lower than stage 3 requirements. For additional information, see GAO, *Aircraft Noise: Information on a Potential Mandated Transition to Quieter Airplanes*, [GAO-20-661](#) (Washington, D.C.: Aug. 20, 2020).

“Schultz Curve”) and then updated in 1992.²⁶ FAA issued the results of its Neighborhood Environmental Survey in January 2021.²⁷ As detailed in table 1, the survey results show a substantial increase in the percentage of people who are highly annoyed by aircraft noise, including at lower noise levels, as compared to earlier survey results.

Table 1: Percentage of People Highly Annoyed by Aircraft Noise

Survey	Percentage of people highly annoyed at Day-Night Average Sound Level (DNL) 50 decibels (dB)	Percentage of people highly annoyed at DNL 55 dB	Percentage of people highly annoyed at DNL 60 dB	Percentage of people highly annoyed at DNL 65 dB
1992 updated Noise Annoyance Curve ^a	1.7 %	3.3 %	6.5 %	12.3 %
2021 Neighborhood Environmental Survey ^b	15.4 – 23.4 %	27.8 – 36.8 %	43.8 – 53.7 %	60.1 – 70.9 %

Source: Federal Aviation Administration. | GAO-21-103933

Notes: The relationship between annoyance and noise exposure can be represented by a dose-response curve. In the case of aircraft noise exposure, the dose is the amount of aircraft noise experienced and the response is the reported level of annoyance. FAA’s selection of DNL 65 dB as the appropriate threshold for noise mitigation for residential areas was based on a noise dose-response curve developed in the 1970’s and then updated in 1992.

^aThe Federal Interagency Committee on Noise developed an updated curve illustrating the relationship between noise and annoyance by combining the findings of the original 1970s survey with results of a later survey. See Federal Interagency Committee on Noise, *Federal Agency Review of Selected Airport Noise Analysis Issues* (Aug. 1992).

^b2021 results reported at the 95 percent confidence interval. See Federal Aviation Administration, *Analysis of the Neighborhood Environmental Survey* (Atlantic City, NJ; January 2021).

According to FAA, while additional research is needed to fully understand the reasons why a greater percentage of people are now highly annoyed

²⁶ The 1992 update—conducted by members of the Federal Interagency Committee on Noise—consisted of an augmentation of the results of the previous Schultz Curve developed in the 1970s with the results of a more recent survey. See Federal Interagency Committee on Noise, *Federal Agency Review of Selected Airport Noise Analysis Issues* (Aug. 1992).

²⁷ See Federal Aviation Administration, *Analysis of the Neighborhood Environmental Survey* (Atlantic City, NJ; January 2021). FAA initiated a statistically representative neighborhood environmental survey of a sample of adults living near 20 U.S. airports, conducted over a 12-month period beginning in October of 2015. The goal of the survey was to produce an updated and nationally representative dose-response curve for the United States.

by aircraft noise, several factors may have contributed to the change, including the following:

- The public may have become more sensitive to aircraft noise at a given DNL level due to changes in the nature of noise exposure (such as changes in the number of flights overhead).
- There may have been changes to how people work and live, including increases in in-home businesses and teleworking as well as changes over time in expectations for spending time outdoors versus indoors.
- The rise of social media, the internet, and other national and global information sources may have led to an increased awareness and perception of local and national noise issues.
- The results may reflect differences in the methodology and populations surveyed in the two studies.²⁸

In conjunction with the release of the new survey results, FAA issued a *Federal Register* notice in January 2021 seeking public comments on its aviation noise research portfolio and the results of the National Environmental Survey.²⁹ Specifically, FAA's request for comments included the following:

- What, if any, additional research should be undertaken in each of the categories of (1) effects of aircraft noise on individuals and communities; (2) noise modeling, noise metrics, and environmental data visualization; and (3) reduction, abatement, and mitigation of aviation noise?
- What factors may be contributing to the increase in noise annoyance shown in the survey results?
- What, if any, additional categories of investigation, analysis, or research should be undertaken to inform FAA noise policy?

²⁸ Some differences in results among the surveys may be explained by differences in the study design, implementation, measurement, or a combination of factors. For example, the original Schultz curve considered annoyance from transportation noise in general, while the 2021 results are based on responses to aviation noise in particular. In addition, advances in technology and statistical theory have resulted in changes in methodology that were not available for previous research.

²⁹ Overview of FAA Aircraft Noise Policy and Research Efforts: Request for Input on Research Activities To Inform Aircraft Noise Policy, 86 Fed. Reg. 2722 (Jan. 13, 2021). Additionally, on May 10, 2021 FAA sent a letter to members of Congress regarding its planned review of the agency's aviation noise policy.

The public comment period closed on April 14, 2021 and FAA received more than 4,000 comments in response. Public comments on FAA's aviation noise research and survey results may assist FAA in understanding noise concerns. However, according to agency officials, FAA will need to review all of the comments prior to identifying next steps. FAA stated that the agency would not revise its aviation noise policy, including use of the DNL metric, until it had considered public and stakeholder input on the agency's research portfolio and survey results.

In the interim, as FAA continues to implement PBN procedures at airports across the country, using additional metrics to supplement its DNL analysis may provide FAA with a better understanding of potential noise impacts, including those that are not considered significant under NEPA. The FAA Reauthorization Act of 2018 required FAA to report on alternatives to DNL and FAA's methods for considering aviation noise.³⁰ In response, FAA issued an April 2020 report to the appropriate committees of Congress that describes a number of supplemental noise metrics (discussed below).³¹ Some members of Congress subsequently expressed concern in a letter to FAA that FAA's report failed to seriously analyze and consider alternatives to the DNL 65 dB standard, or to identify how and when supplemental noise metrics could be used in FAA's flight procedure design decisions or to alleviate existing noise.³²

Prior to the Federal Register notice, FAA made some adjustments to certain aspects of its PBN environmental analysis processes after the public reaction it faced following its initial rounds of PBN implementation, but has not made changes to the metrics used in its analysis. For example, FAA officials said that, compared to the design process for earlier metroplex projects, the design process for recent metroplex projects was more iterative, with the design team reviewing potential noise impacts as they are designing procedures and taking noise into account during the design process, rather than waiting to do noise

³⁰ FAA Reauthorization Act of 2018, Pub. L. No. 115-254, §§ 173, 188, 132 Stat. 3186, 3228, 3236. Section 188 of the Act required FAA to evaluate alternative metrics to the current average day-night level standard, such as use of actual noise sampling to address community airplane noise concerns. Section 173 of the Act required FAA to complete an ongoing evaluation of alternative metrics to the current day night level (DNL) 65 standard.

³¹ Federal Aviation Administration, *Report to Congress: FAA Reauthorization Act of 2018 (Pub. L. 115-254) Section 188 and Sec 173*, (Washington, D.C.: Apr. 14, 2020).

³² Members of Congress, *Letter to Federal Aviation Administration Administrator Steve Dickson*, Washington, D.C.: September 23, 2020.

modeling until after the design is complete. However, these analyses continue to rely on DNL as an indicator of potential noise problems.

FAA policy permits the use of supplemental noise metrics in addition to DNL on a case-by-case basis. As FAA stated in its *Federal Register* notice, changes in the nature of aviation noise may be the cause of the increase in annoyance identified in the survey. To that point, most researchers we spoke with said that DNL is not sensitive to some aspects of noise that can cause annoyance. FAA officials told us that, while agency policies permit the consideration of supplemental metrics, the agency generally does not use supplemental metrics in its analysis of noise impacts because the DNL metric meets the legal requirement that FAA use a metric that incorporates noise intensity, duration, and time of occurrence.³³ The officials stated that the use of supplemental metrics is not necessary in many cases. However, they said that, in unique situations where supplemental metrics can provide new context not provided by DNL, FAA will consider use of appropriate metrics and, when a supplemental metric is considered, the results of those analyses would be made publicly available.

FAA's guidance is unclear, though, about the contexts in which FAA would consider supplemental metrics to be either appropriate or inappropriate. FAA's Order 1050.1 Desk Reference notes that supplemental metrics may be used on a case-by-case basis, and that FAA's current tool for analyzing noise impacts (the Aviation Environmental Design Tool) has the capability necessary to incorporate such metrics. However, the guidance does not identify cases in which the use of supplemental metrics might be appropriate. For instance, the guidance notes that some metrics might be useful in analyzing the possibility for sleep disturbance or speech interference, but does not identify circumstances under which those analyses should be conducted. Further, the Desk Reference notes that additional approval from FAA's Office of Environment and Energy is needed to conduct supplemental noise analysis. FAA officials stated that they would need to ensure that such analysis provides sufficient context for each metric and ample explanation, to ensure they are not confused with DNL. Determining how and when other noise metrics should be used either in place of or in

³³ See 49 U.S.C. § 47502. We note that courts have consistently upheld FAA's discretion to choose its own cumulative noise impact methodology. See, e.g. *City of Bridgeton v. FAA*, 212 F.3d 448, 459 (8th Cir. 2000); *Citizens of the Ebey's Rsv. for a Healthy, Safe & Peaceful Env't v. U.S. Dep't of the Navy*, 122 F. Supp. 3d 1068, 1079–80 (W.D. Wash. 2015).

conjunction with DNL could help FAA to better understand and anticipate potential noise concerns prior to implementation of PBN flight path changes.

As FAA noted in its April 2020 report, many other nations use cumulative metrics similar to DNL in assessing aircraft noise impacts. Additionally, the report stated that no single metric can cover all situations due to the dynamic characteristics of aviation noise. Indeed, any single metric that seeks to account for effects of several different components of noise is likely to obscure the effects of those components individually. As such, using one or more supplemental metrics in concert with DNL may provide FAA with a more holistic picture of the potential noise impacts of PBN projects. Use of such metrics could provide additional insights on potential community noise concerns and offer opportunities to adjust PBN flight paths prior to implementation.

For example, Airservices Australia, which manages air traffic in Australia, has begun to use a variety of metrics and thresholds when evaluating the potential environmental impacts of proposed airspace, including the concept of “noise noticeability.” According to Airservices Australia officials, this change is intended to improve the clarity of the organization’s environmental assessment methodology and address environmental issues in a more comprehensive way. Most researchers we spoke with stated that metrics other than DNL might be more sensitive to the types of noise changes that members of communities might notice. For example, some researchers stated that metrics conveying the number of flights above a given location (see below) would be a useful supplement or alternative to DNL. Considering the “number above” metric during the design process or environmental reviews could help FAA to identify areas likely to experience a large increase in the number of flights overhead. In some cases, even if the impact does not rise to the level of a significant change in terms of DNL, FAA may be able to identify changes to proposed flight paths that could mitigate potential noise impacts while still supporting NextGen safety and efficiency goals.

In its 2020 report, FAA identified a number of alternative metrics that focus on either the noise caused by a single overhead flight or various combinations of information on noise and the number or duration of flights overhead. These metrics may provide insights that could assist in identifying community noise concerns prior to PBN implementation. Some examples of alternative metrics described by FAA include:

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- **Sound exposure level (SEL):** As discussed, SEL is already in use by FAA as one of the components of DNL and provides information on the total noise caused by a single flight overhead.
 - **Number Above:** This metric describes the number of events above a selected sound level threshold over a given period of time (for instance the number of overhead flights that cause more than 60 dB of noise at a given location over a 24-hour period).
 - **Time Above:** This metric describes the total time, or percentage of time, that the aircraft noise level exceeds an indicated level (for example, the amount of time a given location is exposed to noise above 60 dB).

The choice to use other noise metrics and thresholds when assessing the significance of noise impacts is a policy decision for the administration and Congress. As some aviation stakeholders pointed out, making changes to the regulatory metric and threshold of DNL 65 dB would likely have additional consequences because that threshold is currently used to determine eligibility for noise mitigation funding. Using additional metrics for regulatory activities or as a significance threshold could require policymakers to develop new standards against which to judge aircraft noise and balance competing priorities regarding the safety and efficiency of the national airspace, aviation noise, and fuel emissions, among others. Additionally, other available metrics may not incorporate all of the elements of noise required by law (for instance, metrics conveying the number of overhead flights may not account for the duration of noise events).³⁴ It is also important to recognize that the extent to which FAA can address noise impacts identified through the use of supplemental metrics may be limited due to a range of constraints related to airspace safety and security as well as competing priorities such as fuel efficiency.

However, as demonstrated by FAA's guidance on supplemental metrics, the use of the DNL threshold for determining the significance of noise impacts need not preclude the use of additional metrics to increase FAA's understanding of potential noise impacts. Whether the threshold for significant noise impacts is adjusted or not, expanding the information available for FAA's internal analysis when conducting environmental reviews may facilitate FAA's efforts to achieve its goals for implementing PBN by making more informed decisions and, in turn, mitigating some of the challenges that have delayed PBN implementation. For instance, FAA has established a goal to advance PBN implementation but, as reported

³⁴ See 49 U.S.C. § 47502.

by the DOT Inspector General, community noise concerns, among other factors, have led to legal challenges and delays that have reduced the realized benefits of PBN implementation.³⁵

FAA has also set a goal to streamline and improve the environmental review process to make informed decisions more quickly and efficiently and provide for a more predictable, transparent, and timely federal review and authorization process. Further, *Standards for Internal Control in the Federal Government* note that agencies should use quality information that considers the expectations of both internal and external users (such as members of the public) to achieve objectives and address risks. Using supplemental metrics in internal analysis may not be feasible for the noise-screening process used for assessing whether a proposed change is eligible for categorical exclusion because of the more limited nature of those analyses. However, for projects that require an environmental assessment or impact statement—and therefore have more potential to cause noise or other environmental impacts, even if they are not legally significant—continuing to rely solely on existing DNL thresholds to identify potential noise problems may cause further implementation delays as FAA works to implement PBN procedures at airports across the country.

³⁵ DOT Office of Inspector General, *FAA Has Made Progress in Implementing Its Metroplex Program, but Benefits for Airspace Users Have Fallen Short of Expectations*, AV2019062 (August, 2019).

FAA Has Increased Public Outreach, but Improved Communication Tools and Strategies Could Facilitate More Meaningful Public Involvement

FAA Has Increased Pre-Implementation Community Outreach in Response to Community Concerns

NEPA regulations require FAA to make diligent efforts, consistent with the required level of environmental review, to involve the public in preparing and implementing FAA's NEPA procedures for PBN implementation. The extent and type of public involvement is determined on a case-by-case basis within the broad requirements specified for each level of environmental review. As previously discussed, FAA Order 1050.1F establishes processes for conducting public outreach to comply with NEPA requirements to involve the public in preparing and finalizing environmental documentation.³⁶ For each level of environmental review (categorical exclusion, environmental assessment, or environmental impact statements) the Order provides a range of activities that FAA officials can choose from to meet public outreach requirements. For example, outreach to the public could include outreach to airport officials, community members, local elected officials, state and local agencies, or a combination of these groups. Optional public involvement activities that could be conducted when preparing an environmental assessment include circulating the draft environmental assessment for public comment and holding public meetings or workshops. FAA officials told us that—as laid out in the Order—they often look to airports and local officials for insight on where and with whom to conduct outreach.

While outreach for metroplex projects has increased over time, the type and amount of outreach for single-site PBN implementation projects has varied depending on a number of factors. Over time, FAA increased its

³⁶ FAA uses the term community involvement, defined as the process of engaging in dialogue and collaboration with communities affected by FAA actions. FAA frequently uses the term community engagement as well. For the purposes of this report, we use the term community outreach to encompass FAA activities related to informing, educating, engaging, and involving the community on PBN related projects.

public outreach efforts for PBN implementation at metroplex sites within the discretion provided under the Order. FAA officials told us that they frequently go beyond the requirements in the Order in providing outreach on airspace changes to inform the public of the expected impacts. In 2013 and 2014, for the first four metroplex sites, FAA conducted public outreach only with airport officials prior to implementation (see table 2). At the remaining seven metroplex sites, FAA pursued more varied outreach efforts. How FAA conducts public outreach for each project under an environmental assessment is determined on a case-by-case basis and varies with each project. According to FAA officials, FAA's shift toward more extensive community outreach was sparked by community concerns and litigation related to its early PBN implementation efforts.

Table 2: Federal Aviation Administration Community Outreach to Discuss Proposed Performance-Based Navigation Implementation at Metroplex Sites

Metroplex ^a Location	Record of Decision Date ^b	Briefings to Airport Officials	Briefings to Elected Officials	Public Workshops	Webinars	Community Involvement Plan ^c
Houston	June 2013	✓				
Washington D.C.	December 2013	✓				
North Texas	June 2014	✓				
Atlanta	July 2014	✓				
Northern California	July 2014	✓	✓	✓		
Charlotte	June 2015	✓	✓	✓		
Southern California	August 2016	✓	✓	✓	✓	
Cleveland-Detroit	April 2018	✓	✓	✓	✓	✓
Denver	January 2020	✓	✓	✓		✓
Las Vegas	July 2020	✓	✓	✓		✓
South-Central Florida	October 2020	✓	✓	✓	✓	✓

Source: GAO analysis of Federal Aviation Administration information | GAO-21-103933

^aA metroplex is a major metropolitan area with multiple airports and complex air traffic patterns for which FAA has designed performance-based navigation flight paths for several airports concurrently. FAA conducted an environmental assessment for all metroplex projects.

^bRecord of Decision date refers to the date FAA published its Finding of No Significant Impact and record of decision on the final environmental assessment for that location.

^cA community involvement plan is a document to outline standard, repeatable processes to ensure productive and effective community involvement for performance-based navigation projects.

On the other hand, at each of the single-site PBN projects we selected, FAA conducted different levels of community outreach for each project depending on the level of environmental review conducted, complexity of the proposed PBN changes, and the potential impacts.

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- At Chicago O'Hare International Airport, initial implementation of PBN procedures began in 2008 when construction of the first of several runways was completed as part of a larger modernization project, which is being conducted under an environmental impact statement. Prior to implementation, FAA conducted public outreach including scoping meetings, meetings with elected officials and the community, and environmental justice outreach because of the anticipation of significant environmental impacts. When changes to the planned runway construction required a re-evaluation and update of the environmental impact statement in 2015, FAA conducted outreach including public workshops and briefings to local elected officials even though, according to FAA, public outreach is not normally conducted for re-evaluations.
 - For Seattle-Tacoma International Airport, FAA issued the final environmental assessment in 2012. FAA held two public scoping meetings to gather input from communities during the design phase and two public workshops after the release of the draft environmental assessment. According to FAA, the public scoping meetings were not required as part of the environmental assessment.
 - At LaGuardia Airport in New York in 2012, FAA implemented a PBN procedure change under a categorical exclusion, and according to Port Authority officials, FAA conducted outreach to the Port Authority but did not conduct outreach with the surrounding community.

In February 2016, FAA published its Community Involvement Manual, which provides FAA officials with guidance on the public outreach activities outlined above.³⁷ The manual offers practices, tools, resources, and techniques as options that can guide FAA officials in tailoring community involvement for their specific efforts. As described in the manual, the goal for FAA's outreach is to give the public an opportunity to be informed and involved, and to have their concerns and views considered by FAA in decisions that might affect them. Further, the manual acknowledges that changes in traffic levels and aircraft flight paths can generate community concerns about aircraft noise and that FAA must adapt community involvement practices to more effectively identify and address concerns. Doing so, the manual states, does not guarantee outcomes that satisfy everyone, but resulting decisions are more likely to reflect the collective public interest, receive broader

³⁷ Federal Aviation Administration, *Community Involvement Manual*, (Washington, D.C.: February 2016).

community acceptance, and experience fewer implementation and post-implementation problems.

According to FAA, for all metroplex projects implemented after the release of FAA's new community involvement manual, FAA engaged with communities both earlier and later in the process as compared with those implemented prior to 2016.³⁸ For example, for the two locations we selected for which FAA implemented PBN in 2016 or after, FAA conducted pre-implementation community outreach including public workshops and presentations for elected officials. FAA's most recent outreach efforts—for the South-Central Florida Metroplex—included multiple rounds of in-person meetings during the design process, followed by additional virtual meetings after the draft environmental assessment was published.³⁹ FAA officials told us that they incorporated some of the community's concerns into the final environmental assessment for the metroplex, including modifying some routes. Community stakeholders we spoke with said they felt their concerns had been addressed, though they said the process required assistance from an aviation consultant.⁴⁰ FAA completed its implementation of the South-Central Florida Metroplex project in August 2021. As of September 2021, it is unclear what effect these changes have had on communities' experiences.

In addition, since 2016, FAA has continuously made improvements to the information provided during community outreach related to PBN implementation. As part of this iterative process, FAA started using new techniques to convey proposed changes to the community. For example, for early metroplex projects, FAA listed reportable increases in DNL for specific longitude and latitude points in environmental assessment documents but did not provide community members with projected DNL changes if they did not rise to a reportable level. In contrast, for the Southern California Metroplex in 2016 and the subsequent Las Vegas

³⁸ In 2020, as required by the FAA Reauthorization Act of 2018, FAA sent a report to appropriate committees of Congress describing these changes to its community outreach since 2016. Pub. L. No. 115-254, § 176, 132 Stat. at 3229.

³⁹ According to FAA officials, after the draft environmental assessment was published, outreach was conducted virtually due to the Coronavirus Disease 2019 (COVID-19) pandemic. Airport officials and community stakeholders told us they had concerns that people without technical expertise would not be able to discuss their concerns with FAA officials in a back-and-forth manner and that libraries—where many of the environmental review materials were available for the public—were closed due to the pandemic.

⁴⁰ FAA implemented the new procedures in August 2021.

and Denver Metroplex projects, FAA provided electronic files that could be viewed using Google Earth to help people see the change in DNL on a map at locations near their address, regardless of whether they were reportable or not. In 2020, for the South-Central Florida Metroplex, FAA provided a web-based mapping tool to enable members of the community to input their address to see the projected change in DNL at a nearby location based on the proposed new flight path procedures.⁴¹

In addition to the outreach enhancements, FAA created regional Community Engagement Officer positions to act as a liaison between communities and FAA. As provided in the FAA Reauthorization Act of 2018, these officials are required to make recommendations to the Regional Administrator to address concerns raised by the public and improve the consideration of public comments in the decision-making process, among other responsibilities.⁴² According to FAA, as of March 2021, FAA has nine CEO positions and all of those positions are filled. While some of the airport and community stakeholders we spoke with were optimistic that the Community Engagement Officer would be a helpful addition, others said they were unsure what the role of the Community Engagement Officer was. FAA also developed a Community Engagement Officer Handbook that the agency plans to update on a continuous basis, and conducts ongoing training for the Community Engagement Officers to help clarify their roles and responsibilities. The training includes topics such as conflict resolution and basic air traffic knowledge, and FAA officials told us they plan to provide additional training.

Despite Outreach Improvements, Community Concerns Indicate Communication Challenges Remain

While FAA has increased pre-implementation community outreach for recent projects, members of the public and airport officials we spoke with said that communication challenges with the public remain. Specifically, in both early and later PBN implementation locations, most community stakeholders we spoke with said the information on potential noise impacts provided in the environmental assessment documents prior to PBN implementation was neither informative nor detailed enough to understand changes they would experience post-implementation.

⁴¹ See, for example, the “Noise tool,” accessed September 1, 2021, at <https://floridametroplexworkshops.com/workshop.html?sitename=fl>.

⁴² Pub. L. No. 115-254, § 180(b)(2), 132 Stat. at 3230.

Concerns about FAA’s communication of potential noise impacts prior to implementation centered around several key themes:

- **Use of the term “significant”:** FAA environmental documents generally discuss predicted noise impacts in terms of whether those impacts are “significant” based on the established thresholds in regulations and associated FAA materials.⁴³ FAA also uses this terminology in its community outreach. Some community stakeholders we spoke to said that when FAA told them there would be no significant noise impact, they believed that there would be no noticeable impact. However, as discussed above and demonstrated by FAA’s recent Neighborhood Environmental Survey, impacts that do not rise to the level of being significant—meaning the 65 dB threshold defined in FAA’s Order—may still be noticeable to members of the public. As a result, members of the community said they felt FAA misrepresented the expected noise impacts. FAA uses the term significant to characterize noise impacts for purposes of complying with requirements under NEPA and the Order. However, FAA’s guidance in the Order also states FAA should use plain language to provide information to the public in a manner that will facilitate public involvement in decisions affecting the human environment. Additionally, the NextGen Advisory Committee issued a blueprint for community outreach in 2016 that advises FAA to avoid regulatory or legal terminology such as “no significant impact” unless specifically required.⁴⁴ In line with this guidance, including additional information and language in outreach materials to characterize the expected noise changes could help the public better understand predicted impacts.⁴⁵ To address this issue, FAA officials said that, in a November 2020 briefing with elected officials in Raleigh, North Carolina, they tried to be clearer about the meaning of the word “significant” by including the language quoted below. However, FAA

⁴³ For purposes of identifying significant noise impacts under NEPA, FAA considers noise changes as a result of flight path changes to be significant if there is a predicted increase in DNL of 1.5 dB or more in noise sensitive areas (such as residential areas) with a DNL of 65 dB and higher or that would result in the area being exposed to DNL 65 dB or higher.

⁴⁴ NextGen Advisory Committee, *Report of the NextGen Advisory Committee in Response to a Tasking from the Federal Aviation Administration*, (June 2016).

⁴⁵ A Finding of No Significant Impact is a document prepared after completion of an environmental assessment. The document presents the reasons why the agency has concluded that there are no significant environmental impacts projected to occur upon implementation of the action and that an environmental impact statement is not required.

has not incorporated this practice into the Order or accompanying Desk Reference.

FAA Explanation Regarding Significant Impacts

“FAA reference to “no significant increase” refers to established, objective legal standards using metrics that apply to agency projects nationwide. For example, noise impacts are significant if the action would increase noise by DNL 1.5 dB or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dB noise exposure level, or that will be exposed at or above the DNL 65 dB level due to a DNL 1.5 dB or greater increase, when compared to the no action alternative for the same timeframe. FAA is not making a subjective statement about how any one person may perceive any type or amount of noise.”

Source: FAA. | GAO-21-103933

- **DNL does not fully convey the noise created by flights overhead:** As discussed earlier, DNL is limited in what it can reveal about changes to the airspace as experienced by members of the community on the ground. Because FAA’s description of potential noise impacts is grounded in expected changes in DNL—both in its environmental assessments and during its public outreach—communities may not fully understand the extent of changes to expect when being informed of a seemingly small change in DNL. In particular, the concentration of flight paths, which is inherent to PBN, means that all flights in a given vicinity could be concentrated directly overhead certain communities, and likely more noticeable. For example, on Vashon Island near Seattle-Tacoma International Airport, FAA predicted an increase in DNL from 41.5 without PBN, to 43.4 with PBN (an increase of 1.9 dB).⁴⁶ Representatives of the community we spoke with near that location said they used to have four or five flights overhead per day. However, after PBN implementation in 2015, they estimate they were experiencing about 150 flights per day, which they felt negatively affected their lives.⁴⁷

⁴⁶ In the environmental assessment for Seattle, FAA identified this projected change in DNL for Vashon Island as one of the largest potential impacts compared to impacts in other locations around the airport, but said that the DNL values are so low in level to begin with that ambient noise from local community sources (such as road traffic) could partially or totally mask the changes. In Vashon Island, community stakeholders said that the island is more rural and therefore does not have very much ambient noise.

⁴⁷ FAA data on PBN usage for arrival procedures over that location indicate that PBN procedures were used for an average of about 190 flights per day in December 2020, though—according to FAA—averaged about 300 daily operations in 2019. In contrast, FAA officials stated that in 2012—prior to PBN implementation—there was an average of 129 flights over the area per day, though these flights would have been dispersed over a broader flight path.

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- **Lack of detail in FAA materials:** Some airport officials and communities said the graphics and maps provided by FAA were not sufficiently detailed to allow them to accurately understand potential noise changes for their specific neighborhood. For example, community stakeholders around Burbank and Van Nuys airports—for which FAA provided Google Earth files with information on DNL changes—said the maps included in the draft environmental assessment were at a macro scale, rather than at a neighborhood scale, making it difficult to easily determine where the changes and new flight paths were in relation to their location. FAA officials said their graphics and visuals have greatly improved since earlier metroplex projects, beginning with the Southern California Metroplex project, implemented in 2016. The officials stated that they have worked to improve the materials provided, such as providing large boards to depict where the flight paths will be; as well as street level satellite maps to provide more detail to the public. For example, after the initial Southern California Metroplex implementation, FAA officials said they have provided more detailed maps and materials to members of the community in Burbank during outreach related to future PBN changes beyond the metroplex project.

FAA's January 2021 *Federal Register* notice identified possible areas where the agency might make changes that could address the challenges we identified—including the use of confusing terminology, the DNL metric, and unclear graphics—but officials told us they have not committed to making specific changes. The notice states that FAA is currently assessing the use of other metrics and visualization tools to assist the public in better understanding noise impacts and facilitating communication, and has asked for public comments on these efforts. This will likely prove informative, but FAA has not yet planned any efforts to incorporate additional noise metrics into its community outreach. As discussed, FAA has the capability to conduct analysis using supplemental noise metrics, and FAA's Desk Reference identifies several supplemental metrics that can be used to assist in the public's understanding of potential noise impacts. As such, making more immediate changes by consistently incorporating supplemental metrics into outreach may alleviate some of the frustration communities may experience in the nearer term. Indeed, FAA officials identified one situation in which they used an additional noise metric for a recently proposed change to air traffic procedures at San Francisco International and Oakland International Airports. FAA officials stated that they used the "number above" metric in addition to DNL to better communicate noise impacts to members of the local community.

FAA is unlikely to satisfy all members of the public, and noise concerns related to aviation in general and PBN in particular may continue to persist. Nonetheless, providing more holistic information on potential noise impacts during the pre-implementation process for proposed PBN projects may help FAA both to arrive at final procedure designs that help mitigate noise concerns and to develop and maintain more positive relationships with members of the public.

Specifically, using supplemental metrics in outreach materials in addition to DNL to convey information on potential noise impacts during pre-implementation outreach for proposed PBN changes may help provide the public with more understandable or meaningful information. In turn, such information may improve communities' ability to provide insights about their particular noise sensitivities and concerns during outreach, which may enhance FAA's ability to identify potential problems prior to implementation. For instance, some aviation researchers suggested providing additional information on expected changes, such as the number of overhead flights expected at a particular location. Additionally, by using supplemental noise metrics, FAA may be able to identify ways it can add detail to maps or other data visualization tools to convey more meaningful information visually.

Improving the information provided to communities prior to PBN implementation may also help to improve FAA's relationships with community stakeholders. *Standards for Internal Control in the Federal Government* notes that agencies should use quality information that considers the expectations of both internal and external users (such as members of the public) to achieve objectives and address risks. Additionally, best practices established by the Airport Cooperative Research Program for managing community expectations on airport noise suggest using information to build trust and manage expectations. In communities where trust has eroded, FAA may face further challenges as it seeks to continue PBN implementation. For example, when we spoke to members of the community in July 2020, FAA was in the process of implementing new PBN procedures at Burbank Airport separate from the metroplex project. However, community stakeholders there expressed frustration about previous FAA outreach, lack of communication, and their perceptions of noise impacts they have experienced from the prior implementation. As a result, community stakeholders expressed skepticism that FAA would engage honestly for this new project. Indeed, FAA officials told us that the community has lost trust in the data and information that FAA is providing. The officials stated that they have tried to adjust the information provided during outreach to better meet

community expectations. Incorporating additional noise metrics into public outreach, as FAA recently did for changes at the San Francisco and Oakland airports, on a more consistent basis may help FAA to regain the trust of local communities.

Different Expectations For Post-Implementation Outreach May Have Caused Confusion and Frustration among Communities

FAA conducts some post-implementation analyses of metroplex projects to verify that the new procedures and routes meet objectives including efficiency, safety, air traffic controller workload, and capacity. However, this analysis does not require or include an assessment of actual noise impacts. Instead, the analysis is focused on determining the benefits achieved from implementation. Some communities have suggested that FAA should measure actual noise, rather than rely on the noise modeling FAA conducts as part of its environmental analyses. According to FAA, the agency uses noise modeling to assess noise impacts because it is a cost-effective way to estimate noise levels for any location at a point-in-time. As laid out in FAA's 2020 report on DNL and alternative noise metrics, measuring actual noise with monitors on the ground would be cost prohibitive and has additional limitations. These limitations include:

- Non-aircraft sounds can be difficult to separate from aircraft noise during data post-processing.
- Long-term (e.g., year-long) noise monitoring requires regular maintenance and calibration of individual noise monitors on a continuous basis, which could be costly.
- A large number of noise-monitoring locations may be required (e.g. tens of thousands of noise monitors) to match the data developed by noise modeling.

While FAA's post-implementation analyses does not require engagement with community stakeholders to understand the impacts they have experienced, we found that some communities had ongoing noise concerns related to PBN implementation. Based on our interviews, we found public reaction to PBN implementation at our selected sites varied. Airport stakeholders we spoke with at Dallas Fort-Worth and Washington Dulles airports said communities did not report many concerns related to PBN implementation. Some communities—including those around Dallas-Love Field, Chicago-O'Hare, and Palm Beach International—reported feeling optimistic about PBN's potential to help address long-standing noise concerns. For example, at Dallas-Love Field, the community stakeholders we spoke with said PBN implementation reduced aviation noise in residential areas because flight paths were concentrated over commercial areas. However, the majority of the communities we spoke

with had major noise concerns related to PBN procedures that had been implemented in their locations. For example, community stakeholders near LaGuardia Airport said they had relatively low ambient noise prior to PBN implementation, and then they started experiencing louder and more frequent aircraft operations, which caught them by surprise.

Because there is generally no requirement for post-implementation engagement or analysis of noise impacts,⁴⁸ FAA's engagement with communities in our selected locations on noise issues after PBN implementation was limited mainly to engagement with community forums and responding to noise complaints. According to FAA's 2018 *Community Involvement PBN Desk Guide*, following implementation of PBN procedures, FAA's community involvement activities transition away from being project based, and issues related to aircraft noise and noise complaints should be addressed using existing processes, including FAA's and airport authorities' noise complaint mechanisms. All of the airports we selected collect data on noise complaints.⁴⁹ Airport representatives told us that they respond to complaints but generally are not able to address the cause of the noise complaints. For example, airport authorities do not control the types of aircraft in service and traffic volume (generally controlled by the airlines) or flight paths (generally controlled by FAA, in coordination with airlines). FAA officials told us the agency seeks to respond to and address the noise complaints it receives, but that noise complaints cannot be the driving factor to alter existing procedures and routes, which are designed based on the safest and most efficient path to and from an airport. According to FAA, complaints are forwarded to the appropriate FAA regional officials, but the agency encourages people to send their complaints directly to the airport. Some community stakeholders told us the responses they received from FAA

⁴⁸ In some instances, such as when there is a "substantial" change to an already approved project being implemented after an environmental impact statement, FAA may be required to prepare a supplemental environmental impact statement or other supplemental environmental analysis. 40 C.F.R. § 1502.9(d)(1).

⁴⁹ Trends in total annual noise complaints at the selected airports from 2010 to 2019 varied: while some showed steep increases in complaints in recent years, others had ups and downs over time. However, according to some airport and FAA officials as well as researchers we spoke with, when analyzing complaint data, it is important to consider the total number of people submitting complaints (complainants), which may reveal whether noise concerns are widespread or limited to a small group. With the exception of some years at airports with fewer complaints, the number of complaints per complainants generally increased from 2010 to 2019 across all of the selected airports, suggesting noise concerns were concentrated among a small population.

and airports to complaints were generic or did not address their concerns. FAA officials said they try to address concerns but are not always able to fix the cause.

FAA's Community Involvement Manual notes that members of communities can participate in community forums, such as airport roundtables or working groups, as a way to engage with FAA on noise and other aviation issues.⁵⁰ Most of our selected sites have established forums to address noise issues, though the structure and organization vary among our selected locations.⁵¹ At some airports, these forums have existed for many years—decades in some cases—to provide opportunities for addressing concerns related to the airport, while others have been established more recently and specifically in response to PBN implementation. FAA has provided some public guidance on the formation and operation of community forums, primarily through its 2018 Community Roundtable Information Sheet. The information sheet notes that FAA is supportive of airports and communities establishing forums to identify the problems they believe should be addressed, establish goals, and make decisions.

The Information Sheet also identifies steps for how FAA assesses a proposed PBN procedure change. As laid out in the Information sheet, FAA prefers to consider proposed flight procedure changes from organized forums that represent the entire affected community—as opposed to proposals from individuals or segments of the community—because they provide an opportunity to ensure stakeholder coordination and buy-in, leading to long-term solutions that balance competing interests. For instance, proposals developed through coordination with representatives from all communities around an airport may be more likely to consider the noise concerns of all groups, rather than possibly moving noise from one neighborhood to another. FAA first assesses the proposal based on whether the resulting flight path is technically feasible, safe, and efficient, including whether the proposal is consistent with

⁵⁰ While these organizations can take many forms, we will refer generally to organizations designed to represent a community broadly (rather than a small area or specific constituency) to address concerns related to a nearby airport as community forums. Other groups have been established to organize smaller groups of people—such as specific neighborhoods—around their specific aircraft noise concerns.

⁵¹ Each roundtable has bylaws determining who can serve on the roundtable. Roundtables often include local elected officials or community members who were appointed by their elected official. Airport and FAA staff often attend the roundtable and are generally listed as non-voting members.

FAA's goals for PBN procedures (generally, fuel and schedule efficiency). Once that is determined, FAA goes through a formal design process and environmental review in accordance with the NEPA process as described above—including noise analysis—to determine the potential environmental impact of the proposed change. According to the information sheet, these reviews can have many steps, and FAA's ability to conduct the analysis depends on available resources and can take months to years to begin and complete. However, while the Community Roundtable Information Sheet provides details on how FAA may assess the proposals, it does not provide guidance on how forum participants can develop the proposal for submission or the extent of the assistance FAA can provide in developing the proposal. This lack of clarity may have contributed to frustration among some of the community members we spoke with, as discussed below.

Community stakeholders expressed mixed views on the productivity of post implementation engagement. Some community forums we spoke with have had some success in engaging with FAA to alleviate some of their noise concerns. For example, members of the Baltimore Washington International Airport Community Roundtable told us that they have been able to find consensus among community stakeholders. The Roundtable submitted proposed changes to FAA in December 2019, received an update that FAA conducted a preliminary review in the fall of 2020, and as of July 2021 are awaiting a preliminary decision from FAA.

However, other communities we spoke with said that they feel that FAA is just "checking a box" or engaging in bad faith and that FAA will not actually address their concerns. For example, members of the Reagan National Community Working Group expressed frustration with the community forum process. According to members, they submitted recommendations to FAA in 2019 on ways to adjust routes to address noise concerns, but that FAA rejected their proposals, citing security concerns. Members of the roundtable expressed frustration at the rejection and felt more explanation or alternative suggestions from FAA would have been helpful. FAA implemented a different procedure change around the same time in response to security concerns from the United States Secret Service and, according to FAA, took steps to address noise concerns as part of that process. However, from the working group members' perspective, FAA had presented the PBN procedures to the community as final, while federal agencies were provided the opportunity to make changes. As a result, the group said they felt FAA was not honest with them about what is and is not possible when it comes to balancing noise against safety and security. Additionally, representatives

of some communities we spoke with expressed concern that the only way to address concerns about PBN implementation might be to initiate litigation against FAA, which could require financial resources. According to FAA officials, they attempt to incorporate input from communities as often as they can but they cannot always make everyone happy.

In addition, some community stakeholders we spoke with expressed concerns that meaningful engagement with FAA about potential changes to highly technical PBN procedures after they are implemented may require communities to hire consultants or other technical experts. For example, we observed a meeting of the Reagan National Community Working Group during which FAA officials encouraged the South of the Airport committee to hire an aviation consultant to provide technical expertise and assist in developing proposals, noting that the North of the Airport committee had done so. Representatives from the South of the Airport Committee expressed concern to us that hiring a consultant would be financially burdensome, and—while it should be an option—it should not be the standard to get FAA’s attention in addressing noise concerns. Representatives from the North of the Airport Committee told us that community groups need access to subject matter experts in order to engage effectively with FAA, and that the committee has seen a huge difference in its impact since hiring an aviation consultant. Of the seven community forums we spoke with about this issue, five have hired aviation consultants to assist them in their communications with FAA. FAA officials said that although it is not a requirement for community forums to hire consultants, it can be helpful to have technical assistance so that communities can develop more polished proposals and understand early on which changes are technically feasible.

FAA’s roundtable information sheet provides some guidance on technical assistance, but may lead communities to expect more assistance than is available. The information sheet advises that FAA’s Air Traffic Organization can provide technical expertise on airspace procedural design when requested, but is unclear about the extent of the assistance available and does not mention the potential benefits of hiring aviation consultants or other technical experts or explain alternatives if a community is unable to procure such services. FAA officials confirmed that community engagement teams and other FAA officials can provide such technical support to community forums when requested in advance. Members of some of the roundtables we spoke with, however, indicated they did not feel FAA had provided adequate technical support. For example, members of the Los Angeles International Airport Community Noise Roundtable said FAA did provide some technical assistance but

sometimes that assistance was more general than what they were expecting and not specific to their airport. Given the time required to conduct technical reviews, it may not be feasible for FAA to conduct technical reviews of community proposals in perpetuity or to provide extensive assistance in developing the proposals. FAA officials stated that, while community groups frequently want FAA to review multiple flight path designs to identify options that might address concerns, technical consultants hired by the community groups might help to ensure that community proposals are more technically feasible.

Furthermore, FAA may be limited in its ability to address community noise concerns related to PBN through post-implementation outreach while maintaining the safety and efficiency of the airspace—FAA’s primary mission—and without creating new noise concerns for other communities. As discussed in FAA’s NextGen Advisory Committee’s *Blueprint for Success for Implementing* PBN, there are trade-offs when implementing PBN procedures, and the national interest and interests of industry stakeholders must be balanced against the interests of local communities. For instance, security constraints—such as proximity to military installations or other secure airspace—may limit options for moving flight paths away from residential areas. Additionally, FAA officials said that making changes to PBN procedures after implementation can be very difficult, in part because changes to one procedure can create a domino effect, requiring changes to other procedures—which may or may not be possible to change—and additional analysis of those changes to determine the potential environmental impact.

Community concerns about FAA’s sincerity in post-implementation outreach and the availability of technical assistance reflect the difficulty of facilitating meaningful engagement between FAA and members of the public, who are likely to lack the subject matter expertise necessary to propose and discuss complex technical issues such as aircraft flight paths. Additionally, there may be confusion among members of the public about FAA’s vision for post-implementation outreach and the agency’s ability to make changes to address noise concerns. For example, there may be differing expectations between communities and the FAA about the extent to which noise concerns can be considered in relation to other priorities, including the safety and efficiency of the National Airspace System. According to FAA officials, while they are willing to dedicate the time and resources to consider and often accommodate the intent of the request, FAA’s mission of ensuring the safe operation of the air space must be the driving factor for the dialogue.

Standards for Internal Control in the Federal Government notes that agencies should communicate effectively with members of the public so that they can help the agency achieve its goals. However, without additional clarity for members of the public and airports on FAA's expected role and objectives for post-implementation community engagement, on how communities can engage most effectively with FAA on noise concerns after the implementation of PBN changes, and on the level and types of technical assistance that FAA is able to provide in post implementation engagement, communities may not have expertise or contextual awareness necessary to effect change. This situation may lead to frustration with, and distrust of, FAA, which could hinder future PBN and flight procedure projects at these airports. Such clarity could be provided through revisions to FAA's Roundtable Information Sheet, or by providing other public guidance.

Additionally, in its 2021 *Portfolio of Goals*, FAA established a goal to develop informational tools (such as presentations, infographics, and webpages) that can be used to educate and inform airports, local elected officials, and communities.⁵² This goal includes an effort to work with regional FAA officials to develop informational tools on FAA's aircraft noise research programs, including efforts to better understand potential community impacts from aircraft noise and ways to address them. Leveraging this new communication effort to provide additional information on FAA's post-implementation outreach efforts could help to better align FAA and community expectations for that engagement.

Conclusions

The appropriate amount of aircraft noise or change in aircraft noise, and the regulatory thresholds at which FAA and others must take steps to mitigate noise are policy decisions for the administration and Congress. FAA's recent request for public comments on its aircraft noise research and metrics may help FAA identify innovative strategies for measuring, communicating, and addressing aircraft noise. Using supplemental noise metrics—whether in conjunction with or instead of the DNL 65 dB criteria—in both FAA's internal analysis and external communication with communities could have immediate benefits. These include (1) better positioning FAA to anticipate community noise concerns, (2) enabling airports and communities to more meaningfully engage in pre-implementation outreach to assist FAA in anticipating noise problems before they occur, and (3) mitigating some of the mistrust and concern

⁵² Federal Aviation Administration, *Fiscal Year 2021 Portfolio of Goals* (Washington, D.C.) 35.

about FAA that has developed on the part of communities in response to PBN implementation. These benefits, in turn, may lead to a reduction in post-implementation noise concerns, though it is unlikely FAA will be able to eliminate those concerns. Similarly, in those instances where the public has noise concerns after PBN implementation, it would be beneficial for community forums to have additional guidance and information to better understand how they can engage meaningfully with FAA. Enhancing existing guidance to forums to set expectations and provide additional information may help to alleviate the feelings of distrust and frustration that have developed in some locations, as well as facilitate future interactions.

Recommendations for Executive Action

We are making the following three recommendations to the FAA:

The Administrator of the Federal Aviation Administration should identify appropriate supplemental noise metrics, such as the “number above” metric, and circumstances for their use to aid in FAA’s internal assessments of noise impacts related to proposed PBN flight path changes. (Recommendation 1)

The Administrator of the Federal Aviation Administration should update guidance to incorporate additional communication tools that more clearly convey expected impacts, such as other noise metrics and visualization tools related to proposed PBN implementation. (Recommendation 2)

The Administrator of the Federal Aviation Administration should, related to post-implementation outreach, provide clearer information to airports and communities on what communities can expect from FAA, including the technical assistance FAA can provide. (Recommendation 3)

Agency Comments

We provided a draft of this report to the Department of Transportation (DOT) for review and comment. In its comments, reproduced in appendix III, DOT concurred with our recommendations. DOT also provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees, members of Congress, the Secretary of Transportation, and other interested parties. In addition, the report is available at no charge on the GAO website at <https://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-2834 or KrauseH@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix IV.

A handwritten signature in black ink that reads "Heather Krause". The signature is written in a cursive style with a large, stylized initial 'H' and a long, sweeping tail on the 'e'.

Heather Krause
Director, Physical Infrastructure

List of Requesters

The Honorable Peter A. DeFazio
Chairman
Committee on Transportation and Infrastructure
House of Representatives

The Honorable Karen Bass
House of Representatives

The Honorable Donald S. Beyer, Jr.
House of Representatives

The Honorable Suzanne Bonamici
House of Representatives

The Honorable Julia Brownley
House of Representatives

The Honorable Salud O. Carbajal
House of Representatives

The Honorable Katherine Clark
House of Representatives

The Honorable Angie Craig
House of Representatives

The Honorable Theodore E. Deutch
House of Representatives

The Honorable Anna G. Eshoo
House of Representatives

The Honorable Raúl M. Grijalva
House of Representatives

The Honorable Eleanor Holmes Norton
House of Representatives

The Honorable Ro Khanna
House of Representatives

The Honorable Mike Levin
House of Representatives

The Honorable Ted W. Lieu
House of Representatives

The Honorable Alan S. Lowenthal
House of Representatives

The Honorable Carolyn B. Maloney
House of Representatives

The Honorable Grace Meng
House of Representatives

The Honorable Grace F. Napolitano
House of Representatives

The Honorable Joe Neguse
House of Representatives

The Honorable Ilhan Omar
House of Representatives

The Honorable Jimmy Panetta
House of Representatives

The Honorable Mike Quigley
House of Representatives

The Honorable Jamie Raskin
House of Representatives

The Honorable Kathleen M. Rice
House of Representatives

The Honorable Harley Rouda
House of Representatives

The Honorable John P. Sarbanes
House of Representatives

The Honorable Janice D. Schakowsky
House of Representatives

The Honorable Adam B. Schiff
House of Representatives

The Honorable Brad Sherman
House of Representatives

The Honorable Adam Smith
House of Representatives

The Honorable Jackie Speier
House of Representatives

Honorable Tom Suozzi
House of Representatives

The Honorable Nydia M. Velázquez
House of Representatives

The Honorable Frederica S. Wilson
House of Representatives

Appendix I: Site-Selection Methodology and Stakeholders Contacted during the Course of This Review

To achieve a broad range of perspectives on the Federal Aviation Administration's (FAA) implementation of performance-based navigation (PBN), related community noise impacts, and the extent and quality of FAA's related community outreach, we selected 13 airports, which are located in seven geographic areas across the country. To ensure our selected locations had relevant experiences with PBN implementation as well as air traffic levels that might make aircraft noise a concern, we limited our selections to those airports included in one of FAA's 11 metroplex projects, which involve PBN implementation at multiple airports within a geographic area,¹ or those airports designated by FAA as a "Core 30" airport.² From within that group, we considered the following factors to achieve a range of perspectives:

- PBN implementation status: we selected sites in various stages of implementation to identify changes in FAA's approach over time and the effects of those changes.
- Metroplex status: To identify differences in FAA's approach between airports designated as part of a metroplex and those that are not (commonly referred to as "single-sites") we chose airports both within and outside of metroplex projects. For metroplex projects, we selected two or three airports from those included in the metroplex (as noted below).
- Community noise concerns: To ensure a diversity of opinions, we selected locations with widespread concerns about noise related to PBN implementation as indicated by past or present litigation on this issue as well as locations without such litigation (though those communities may also have concerns about noise).
- Geographic diversity
- Airport traffic level and trends:
 - To account for differences in FAA's approach and community concerns among large and small airports, we chose both large and small airports based on annual operations. For metroplex

¹ FAA defines metroplexes as metropolitan areas with multiple airports and complex air traffic flows. The FAA has completed 11 metroplex projects.

² FAA defines Core 30 airports as the 30 airports with the highest volume of traffic.

projects, we selected both large and small airports within each metroplex.³

- FAA and other stakeholders have identified recent increases in traffic in some locations as factors contributing to community concerns about noise that are apart from concerns related to PBN implementation. We chose locations that have experienced a large increase (more than 10%) in overall operations since 2014 as well as those at which traffic has remained the same or decreased.

Based on these criteria, we selected the following case study locations:

- Single site projects:
 - Chicago O'Hare International Airport, located in Chicago, Illinois;
 - LaGuardia Airport, located in Queens, New York;
 - Seattle-Tacoma International Airport, located in Seattle, Washington;
- Metroplex projects:
 - North Texas Metroplex: Dallas Fort Worth International Airport and Dallas Love Field Airport;
 - South-Central Florida Metroplex: Fort Lauderdale Hollywood International Airport and Palm Beach International Airport;
 - Southern California Metroplex: Los Angeles International Airport, Hollywood-Burbank Airport, and Van Nuys Airport; and
 - Washington, D.C. Metroplex: Washington Dulles International Airport, Baltimore-Washington International Thurgood Marshall Airport, and Reagan National Airport.⁴

³ For single site projects, we selected sites from among Core 30 airports, and defined a large airport as an airport with average annual operations from 2014-2018 greater than 405,380 (above average annual operations) and a small airport as average annual operations from 2014-2018 less than 405,380. For metroplex projects, we selected both large and small metroplex projects (defined based on whether the overall annual operations were above or below the average for all metroplex projects). From each selected metroplex, we selected at least one airport with average annual operations above 200,000.

⁴ After the initial site selection process, GAO received a request from Congresswoman Eleanor Holmes Norton to add Reagan National Airport to GAO's site-selection. Based on the airport's inclusion in the Washington, D.C., metroplex and the unique challenges caused by proximity to several restricted airspaces, we added this site to our selection.

Appendix I: Site-Selection Methodology and Stakeholders Contacted during the Course of This Review

At each of the selected sites, we spoke with representatives from a variety of airport and community organizations as well as regional FAA and local government officials, as listed in table 3. For each selected airport, we spoke with representatives of airport noise roundtables, if there was one, as well as other community representatives selected to include communities that had been involved in aircraft noise issues based on recommendations of airport and FAA officials as well as our independent research.

Table 3: List of Stakeholders GAO Interviewed during the Course of this Review

Location	Stakeholder
Chicago O'Hare International Airport	Chicago Department of Aviation
	FAA Great Lakes Regional Administrator's Office
	O'Hare Noise Compatibility Commission
LaGuardia Airport	Port Authority of New York and New Jersey
	FAA Eastern Regional Administrator's Office
	Queens Quiet Skies
	New York Community Aviation Roundtable- LaGuardia
North Texas Metroplex	Dallas-Fort Worth International Airport
	Dallas-Love Field Airport
	FAA Southwest Regional Administrator's Office
	Love Field Environmental Advisory Committee (community group focused on environmental issues at Love Field Airport)
Seattle-Tacoma International Airport	Port of Seattle
	FAA Northwest Mountain Regional Administrator's Office
	Seattle-Tacoma International Airport Stakeholder Advisory Roundtable
	Beacon Hill Seattle Community Noise Team
	Beacon Hill Council
	North End Neighbors Airplane Noise Group
	Quieter Skies Task Force Seattle
	El Centro De La Raza
Vashon Island Fair Skies	
South-Central Florida Metroplex	Broward County Aviation Department
	Palm Beach International Airport
	FAA Southern Regional Administrator's Office
	Fort Lauderdale Airport Noise Abatement Committee
	Citizen's Committee on Airport Noise for Palm Beach International Airport
Southern California Metroplex	Los Angeles World Airports
	Hollywood Burbank Airport

Appendix I: Site-Selection Methodology and Stakeholders Contacted during the Course of This Review

Location	Stakeholder
	FAA Western-Pacific Regional Administrator's Office
	Southern San Fernando Valley Airplane Noise Task Force
	Studio City for Quiet Skies
	Neighborhood Council Valley Village
	Van Nuys Airport Citizens Advisory Council
	Valley Village Residents Association
	Sherman Oaks and Encino for Quiet Skies
	Encino Neighborhood Council Airport Committee
	Benedict Hills Home Owners Association
	UproarLA (a community group concerned with airport noise around Hollywood Burbank Airport)
Washington, D.C. Metroplex	Metropolitan Washington Airport Authority
	Maryland Aviation Administration
	FAA Eastern Regional Administrator's Office
	BWI Community Roundtable
	DCA Community Noise Working Group

Source: GAO. | GAO-21-103933

For additional perspectives, we spoke with national community groups, aviation stakeholders, and researchers selected based on contributions to relevant research, recommendations from industry stakeholders, or aviation stakeholders previously identified in GAO work. These stakeholders are listed in table 4.

Table 4: List of Researchers and Aviation Stakeholders GAO Interviewed

Researchers and Aviation Stakeholders
Airlines for America
Airports Council International
Airservices Australia
Civil Air Navigation Services Organization (CANSO)
Dirk Schreckenber- Center for Applied Psychology ZEUS GmbH (A social science and psychology research consultancy based in Germany)
John Hansman- Massachusetts Institute of Technology
Juan Alonso- Stanford University
Mary Ellen Eagan- Harris, Miller, Miller, & Hanson Inc. (HMMH)
MITRE (a federally-funded research and development center that conducts research on aviation topics)
National Organization to Insure a Sound Controlled Environment (N.O.I.S.E.)
National Quiet Skies Coalition

Appendix I: Site-Selection Methodology and Stakeholders Contacted during the Course of This Review

Researchers and Aviation Stakeholders

San Diego County Regional Airport Authority

Sanford Fidell- Fidell Associates Inc.

Truls Gjestland- SINTEF (A Norwegian research organization)

United Kingdom National Air Traffic Services (UK NATS)

Volpe Center (a research center founded by the U.S. Department of Transportation to provide expertise on multimodal transportation)

Source: GAO. | GAO-21-103933

Due to the varying experiences of the groups we spoke with, not all stakeholders had opinions on all questions or issues during our interviews. Accordingly, we do not enumerate stakeholder responses in the report. Instead, we analyzed the responses and reported on common themes that arose during the stakeholder interviews. In some cases, we refer to “some” stakeholders if representatives of between three and five of the relevant groups (for instance, airport officials or community representatives) expressed a similar view, or “most” stakeholders if representatives of more than half of the relevant groups expressed a similar view. Because we selected a non-generalizable sample of stakeholders, their responses should not be used to make inferences about a population. However, we believe that the variety of stakeholders represented provide a good basis for describing the range of experiences and opinions stakeholders have had with FAA’s implementation of PBN.

Appendix II: Analysis of Day-Night Average Sound Level (DNL)

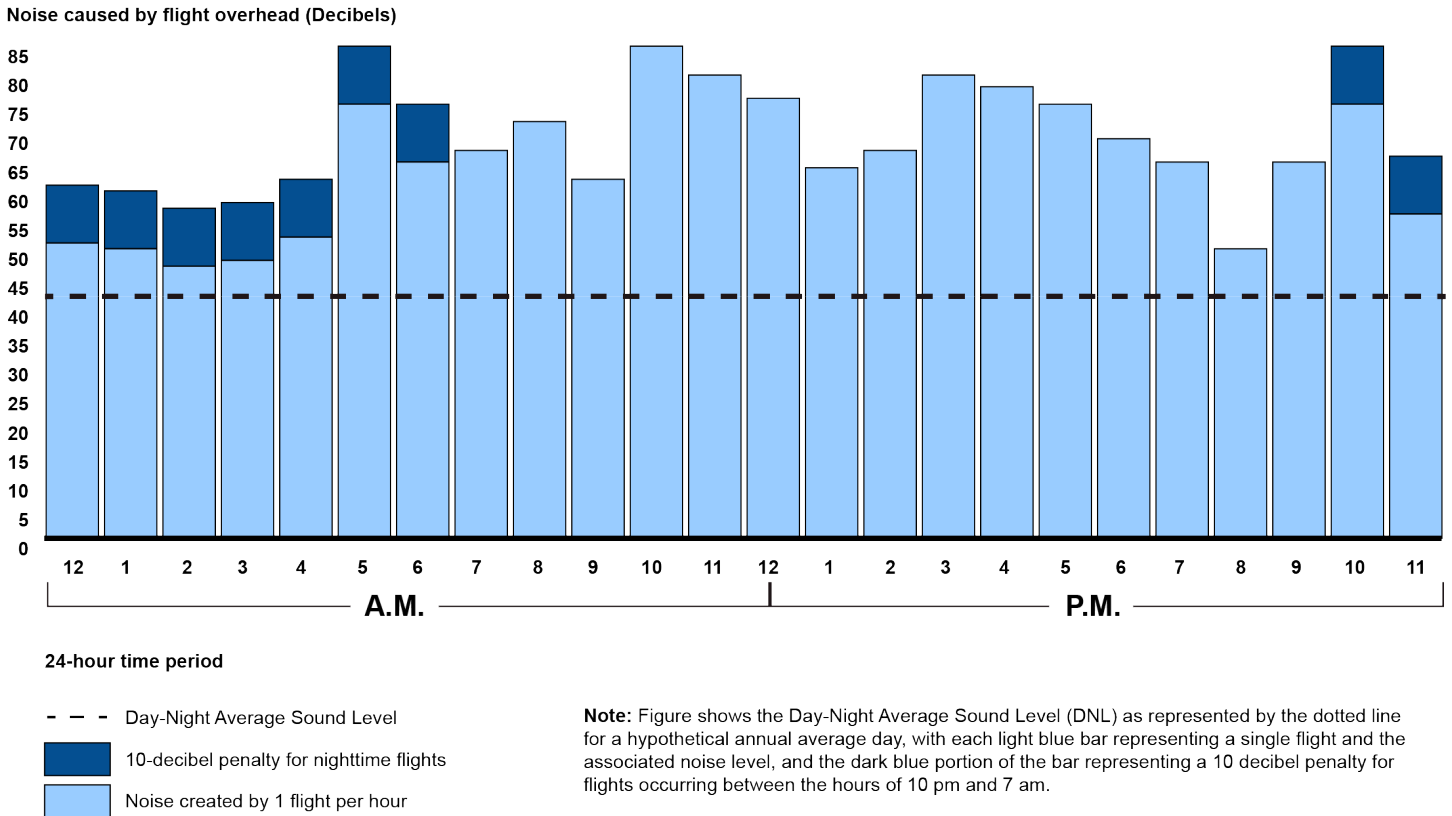
This appendix provides information on the methodology we used for analyzing how the Day-Night Average Sound Level (DNL) metric reflects changes in the number, timing, and noise level of individual flights overhead of a particular location. The Federal Aviation Administration (FAA) assesses the potential noise impact—in terms of changes in DNL—of proposed agency actions, including performance-based navigation (PBN) flight path changes, at locations within the area surrounding an airport. As shown in figure 5, DNL accounts for (1) the amount of noise from each aircraft operation (as represented using the sound exposure level (SEL));¹ (2) the average annual operations per day above the given location (that is: the number of annual overhead flights, averaged over 365 days);² and (3) the time of day the aircraft operations occur (operations occurring between 10 p.m. and 7 a.m. are assigned an extra 10 decibels (dB), weighting them more than day-time operations).³

¹ Sound exposure level (SEL) represents the acoustic energy (that is, the sound pressure) of an individual noise event as if that event had occurred within a one-second time period. By “squeezing” all the noise energy from the event into one second, SEL provides a uniform way to compare noise events of various durations. SEL is expressed in decibels (dB). The formula for calculating DNL equates the SEL for all flights occurring during a 24-hour period into the equivalent sound level (LEQ), which measures the average acoustic energy over a given period of time (in the case of DNL, 24 hours, with an additional night time weighting factor applied). While SEL represents the noise energy of a single noise event (a single flight overhead) as if it occurred within 1 second, LEQ represents the SEL for all the noise events at that location over a 24-hour period.

² While the DNL metric is not defined based on an average annual day, FAA policy uses the DNL for the average annual day to determine whether potential noise impacts are significant when conducting environmental analyses.

³ In making decisions related to noise impacts, FAA must use a metric that considers the magnitude (loudness), duration, and frequency of aviation noise events in its environmental decision making process. See 49 U.S.C. § 47502.

Figure 5: The Day-Night Average Sound Level Accounts for the Number, Timing, and Noise Created by Flights Overhead



Source: GAO analysis of Federal Aviation Administration information. | GAO-21-103933

This analysis is intended to provide highly simplified illustrative examples using hypothetical scenarios to demonstrate how DNL is affected by changes in the noise level of aircraft overhead for a hypothetical location, the number of flights overhead for that location, and the timing of those flights (that is, whether they take place during daytime hours—between 7 am and 10 pm—or nighttime hours—between 10 pm and 7 am). To make the effect of each variable clear, we developed a tool to calculate the DNL for different scenarios assuming a single class of aircraft using a single mode of operation along a single flight path for each scenario (thus, DNL when the noise created by overhead aircraft at a specific location is held

constant for that example).⁴ It is unlikely that, in a real-world scenario, each overflight for a given location would all contribute the same level of noise: SEL is dependent on the type of aircraft (weight, age, and size); the speed of the aircraft; and the distance of the aircraft from the listener at the closest point along its flight path. As such, our hypothetical scenarios include several assumptions to enable comparison across scenarios. These assumptions include:

- Our examples assume the same type of aircraft (same age, technology, and size) and the same weight, including the weight of passengers, cargo, and fuel.
- Our examples assume each overflight is flown at the same place in the sky at the same speed and altitude.

We used the formula for calculating DNL when the aircraft and flight path are held constant developed by the U.S. Environmental Protection Agency.⁵ Each calculation represents a different scenario for an average annual 24-hour period (that is, an average day of hourly weighted noise levels over the course of a year). Using this method, an endless number of flights/noise events at an endless variety of noise levels can be used to calculate the average annual number of flights overhead and noise level for a hypothetical location. This calculation also accounts for the 10 db penalty for flights between the hours of 10 p.m. and 7 a.m. The formula we used to calculate partial DNL for the purpose of this analysis is:

Formula for Calculating Partial Day-Night Average Sound Level (DNL)

$DNL(i,j) = \text{Sound Exposure Level}(i,j) + 10 \log(\text{Number of Daytime Operations}(i,j) + 10 (\text{Number of Nighttime Operations}(i,j)) - 49.4$

where i = the given aircraft class

where j = the given operational mode of the aircraft

Source: U.S. Environmental Protection Agency. | GAO-21-103933

To inform our development of each scenario, we considered actual examples of the average number of flights overhead and predicted changes in DNL at our selected locations. For instance, we considered

⁴ This calculation is referred to as the “partial DNL” by the U.S. Environmental Protection Agency. See U.S. Environmental Protection Agency, *Calculations of Day-Night Levels (Ldn) Resulting from Civil Aircraft Operations*, EPA 550/9-77-450 (Washington, D.C.; January 1977).

⁵ U.S. Environmental Protection Agency, *Calculations of Day-Night Levels Resulting from Civil Aircraft Operations*, EPA 550/9-77-450 (Washington, D.C.; Jan. 1977).

the average daily usage of PBN flight paths for our selected locations to determine the range in the number of flights overhead it would be reasonable to include in our analyses.⁶ Additionally, we considered changes in DNL that FAA predicted in environmental assessments we reviewed for our selected locations to understand the extent and range of potential noise impacts FAA identified in our selected locations. The real world situations FAA analyzes to identify the potential noise impacts of proposed actions are much more complex than those presented in our analysis. For example, those analyses must consider changing weather patterns, the precise mix of aircraft types in use at each airport, and predicted mix of destinations and points of origin for each flight to and from the airport. However, we believe this simplified analysis accurately demonstrates how changes in DNL relate to expected changes in the number of flights overhead and the noise created by each flight at a hypothetical location.

⁶ FAA tracks and reports usage statistics for published PBN procedures in its Performance Based Navigation Implementation and Usage Dashboard. We reviewed documentation for this system and interviewed knowledgeable officials about its limitations. While inclusion in these PBN usage statistics does not imply complete adherence of a flight to the published PBN procedure, we believe it is reliable for the purpose of understanding the range of flight frequencies that could be expected at locations under PBN flight paths.

Appendix III: Comments from the Department of Transportation



**U.S. Department of
Transportation**
Office of the Secretary
of Transportation

Assistant Secretary
for Administration

1200 New Jersey Avenue, SE
Washington, DC 20590

September 8, 2021

Heather Krause
Director, Physical Infrastructure Issues
U.S. Government Accountability Office
441 G Street NW
Washington, DC 20548

Dear Ms. Krause:

The Federal Aviation Administration (FAA) is committed to ensuring the safe and efficient use of the National Airspace System (NAS). We are also committed to substantial engagement with communities on all types of aviation noise issues. Thus, the FAA has established regional community engagement teams, which closely monitor noise concerns impacting communities across the U.S. These engagement teams include representation from all business lines within the FAA. FAA continues to manage the NAS safely and efficiently while exploring opportunities to reduce noise impacts.

Upon review of the draft report, the Department concurs with the three recommendations to identify appropriate supplemental noise metrics, update guidance to incorporate additional communication tools, and provide clearer information to airports and communities on post-implementation. We will provide a detailed response to the recommendations within 180 days of the final report's issuance.

We appreciate the opportunity to respond to GAO's draft report. Please contact Madeline Chulumovich, Director of the Office of Audit Relations and Program Improvement, at (202) 366-6512 with any questions or a request for additional information.

Sincerely,

A handwritten signature in black ink, appearing to read "P. McNamara".

Philip A. McNamara
Assistant Secretary for Administration

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

Heather Krause, (202) 512-2834 or KrauseH@gao.gov.

Staff Acknowledgments

In addition to the contact named above, the following individuals made important contributions to this report: David Sausville, Assistant Director; Katie Hamer, Analyst-In-Charge; Alexandra Jeszeck; McKenna Stahl; Camilo Flores; Delwen Jones; Madhav Panwar; Malika Rice; and Kelly Rubin.

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